POWER

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Making a Hobby of Work

"TO SEE that man carry bricks is like reading poetry," observed one who was watching a large building under construction.

That was a compliment—as fine a compliment as could be paid anyone. Perhaps the man who was doing the carrying would not have appreciated it; but the chances are that he would, though probably his life had little time in it for poetry.

What a wonderful thing it would be if all of us could make our daily tasks smooth and enjoyable, so that we could look forward to them with pleasure, instead of—as is too often the case—just so much time taken out of our lives.

Many men toil day after day at work that is disagreeable, never realizing that other men have done the same thing before, and often are right beside them, enjoying it immensely. What is more, many men engaged in hard physical or mental effort actually take keen interest and pleasure in shop or office.

Each appreciates the progress of the department in which he happens to be employed, just as though the whole success of the thing depended upon him alone. Each is enthusiastic over any special achievement in his branch of the work and gratification beams from him when he has done something particularly well.

These men are not boot-lickers, looking for special approbation from the man next higher up. They are simply those who gain supreme satisfaction in life from good work well done. Some of them are blessed by heaven with the capacity for being more than contented with every opportunity for doing something, for producing something, for gaining more of the feeling that they have advanced the world another little notch on its way to perfection; and it means more than passing satisfaction to them to feel that those who are to follow will say, "He who went here built a good road."

But not all of these fortunate men have their contentment sent to them from the gods. Some discover it for themselves. Take the case of a man who had gone through years of his life before he learned the secret. This particular man came across a problem that seemed beyond his knowledge and experience; so he referred it to his foreman. But for some curious reason that he could never explain, he became interested in learning who would find the answer to the thing that had puzzled him.

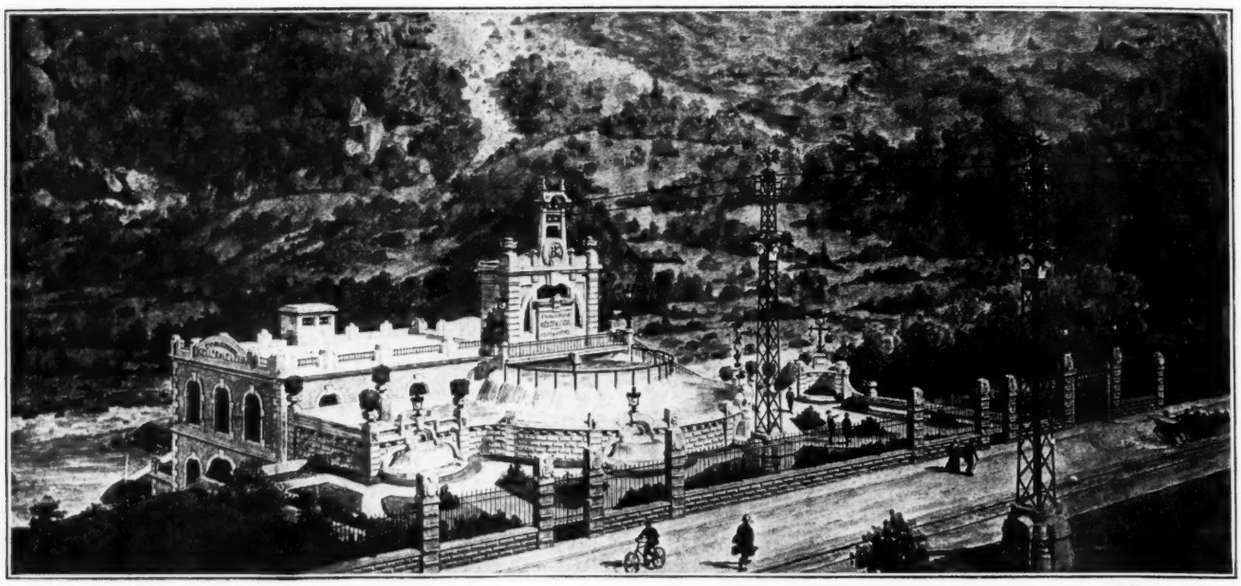
He saw the paper go from the foreman to the superintendent and made an excuse to follow it. He passed the glass door as the big man looked at the sheet, wrinkled his brows and reached for a book. This action made him hesitate so that he might see what followed, and he was asked to come into the office. The superintendent talked the matter over with him, and showed him how to work out the problem; and then he had the surprise of his life, for the book that was being consulted was one that he already owned, but which had lain on his mantelpiece, untouched, for more than a year.

He saw how easily the foreman or he himself could have settled the question had either of them thought to use common sense, and that was the turning point in his career. When he reached home that night, he took down his copy of the book and dug out some practice problems. Within a week, since he was already familiar with the shop practice, he had practically mastered the subject matter and had inquired at the library for more along the same line. He was surprised to find that there was so much interesting and helpful material to be easily secured, and from that day he was a student.

It is doubtful whether other men have as good a time at the theater as this man gets from his evenings of study. He has made the thing a hobby, and it is an inspiring sight to see the change in him. Whereas he once honestly dreaded his work, now he is eager for new things to come up for his wits to tackle. He has been promoted a number of times, but the joy of his work is no longer wholly in the prospect of a fat envelope on Saturday. It is in the daily task as it comes to him. He has found freedom by becoming so familiar with the problems in his department that they no longer hold any terrors for him. Obstacles are things of special interest.

If this were merely a fairy tale and were to have a moral, it would be, "Make your work your hobby." But those who will not see a moral until it is pointed out will not act on it afterward; so the reader may draw his own.

Contributed by Benjamin Ogden Wilkins



Hydro-Electric Development at Vernes

VIRTUALLY abandoned before the war on account of apparently insurmountable ownership difficulties, this project was the object of a new plan conceived and organized at the end of 1916 by C. A. Keller, of the Société des Etablisséments Keller & Leleux. Begun Apr. 1, 1917, the works were carried out in sixteen months, including a winter during which a large part of the outside operation was suspended. All the technical studies of the project were made by the company's organization.

The hydraulic works were put under pressure on July 27, 1918, without incident. Labor was supplied almost exclusively by German prisoners. In particular the tunnel was constructed by them under the direction of only a few skilled workmen.

The Vernes plant required neither dam nor intake since it uses the discharge of the Livet plant, nearly half a mile distant. The supply of water to Vernes is by a continuation of the discharge channels of the Livet plants, which for this purpose have been continued under the present plant without interrupting its operation. The water thus collected is led first to an intermediate open chamber supplied with a surface spillway for part-load operation and then is carried through a tunnel 620 m. (2034.22 ft.) long and 16 sq.m. (172.2 sq.ft.) in cross-section excavated entirely in rock, and continued by a reinforced-concrete conduit of 132 m. (433.09 ft.) length and 3.6 m. (11.81 ft.) diameter built at the bottom of a trench 11 m. (36.09 ft.) deep and subsequently backfilled. The conduit passes under the national highway and under the railway, both carried by a reinforced-concrete bridge, and ends at a circular forebay.

The reinforced-concrete conduit is under pressure due to a head of 8.5 m. (27.89 ft.) at its lower end. Building the hydraulic works offered serious difficulties because of the depth below ground, which made it necessary to raise most of the excavation and the water through shafts over 10 m. (32.81 ft.) deep. Moreover, the reinforced-concrete conduit had to be built at the bottom of a deep timbered and strongly braced trench.

The entire tunneling was carried on with compressed-air tools, requiring the installation of three electric compressor plants, aggregating 200 horsepower.

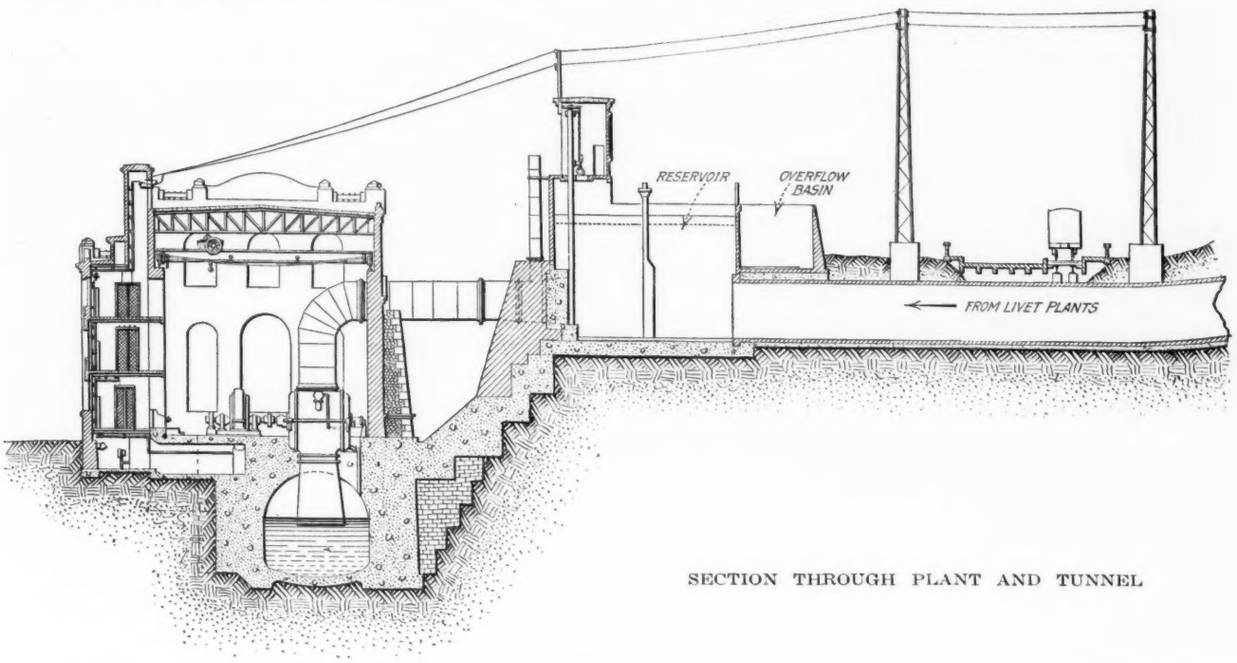
The forebay is of reinforced-concrete and consists of a circular supply reservoir for the penstocks, with the upper rim forming a spillway and an exterior basin receiving the overflow to lead it to a discharge chamber from which pass two steel discharge conduits of 2 m. (6.56 ft.) diameter. This arrangement permits of obtaining a spillway with the necessary surface area to provide for reduction of load or shutdown of the plant and to make sure of the certain and dependable carrying off of the large flow that thus might be suddenly set free. The depth of the supply conduit and its distance from the natural watercourse made it impossible to arrange an ordinary surface spillway. The outer basin, receiving the water from the spillway of the forebay, supplies the two discharge pipes, whose outfall velocity is naturally controlled by the discharge and whose degree of filling determines the discharge velocity. Its operating range has as a maximum the filling of the basin, and the discharge tubes are then under pressure and flows as free orifices. In the latter condition the discharge velocity is 15 m. (49.22 ft.) per sec. and the full flow can be discharged. To check the discharge velocity, the outlet openings are submerged in the waters of the discharge channel. This general arrangement offers the advantage of diverting the surge waters to the dis-

DISCHARGE CONDUITS

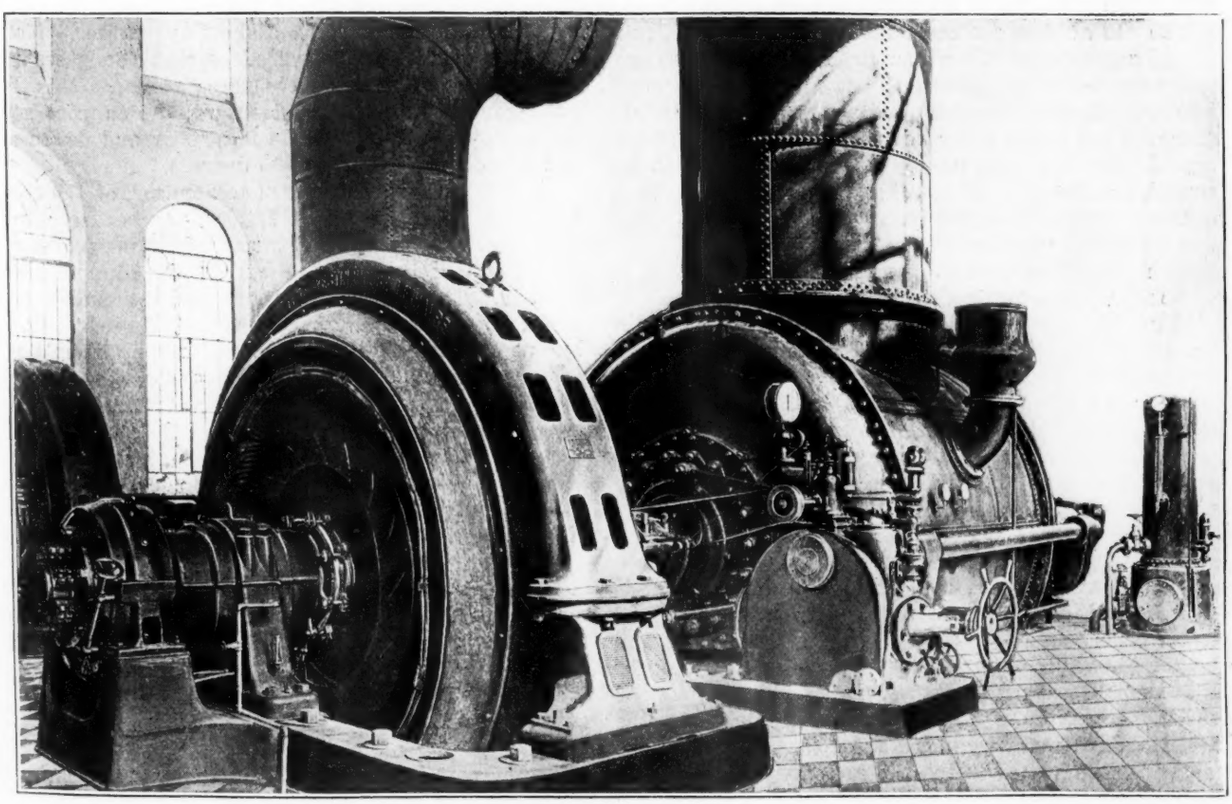
charge canal, in such a way that the variations of load do not cause variations of flow and in consequence no disturbance is occasioned the operation of the water-power plants downstream.

The downstream wall of the forebay contains two gates, each controlling a steel conduit of 2.5 m. (8.20 ft.) diameter, which feeds a turbine of 3500 hp. These gates are operated electrically by means of two motors of 25 hp. each. They are separately controlled from the switchboard of the generating station.

Each unit consists of a Francis turbine connected to a single-phase alternator. The controls of the guide vanes are rigidly coupled by an exterior shaft receiving its movement from a regulator through a servo motor, operated by oil under pressure, made subject to manual control at the switchboard by means of a small electric motor. The oil pressure is obtained by compressed air stored in a reservoir fed by a compressor driven from the turbine shaft. The alternators each have a capacity of 3000 kv.-a. and furnish current to the sys-



SECTION THROUGH PLANT AND TUNNEL



HYDRAULIC TURBINE-DRIVEN GENERATING UNITS AT THE VERNES PLANT

tem at 5000 volts and 25 frequency, at a speed of 375 revolutions per minute.

PLANT DATA

Flow per second	35,000 liters	(1235.85 cu.ft.)
Head realized	20.5 m.	(67.26 ft.)
Underground canal below the plant, length	208 m.	(682.45 ft.)
Tunnel under the mountain, cross-section	16 sq.m.	(172.2 sq.ft.)
Tunnel under the mountain, length	620 m.	(2034.22 ft.)
Diameter of the two steel penstocks	2.5 m.	(8.20 ft.)
Power of each of the hydroelectric units	3,500 hp.	
Average labor force	350	
Total man-days	167,000	

The two units feed in parallel a double transmission line to the new works of "Champ de L'Eglise," in conjunction with the present Livet works, the units of the Vernes and those of the Livet plants operating in parallel.

The switch and control board has all its operating panels on the ground floor. A storage battery supplies the relays of the automatic switches. This battery is charged by direct current brought from the Livet plants by a special line.

At the Champ de L'Eglise plant is a series of electric furnaces of 2750 hp. and one of 3500 hp., producing 80 tons of electric steel daily. This plant is to include in the future a steel works, forge shop and rolling mill. Its present ground area is 14,000 sq.m. (150,640 sq.ft.).

High-Pressure Steel Economizers at Kansas City

THE trend of present day boiler practice is not only toward larger boilers and higher pressures but also higher ratings. These conditions lead to high flue gas temperatures and great weight of gases passed in a unit time interval, so that economizers are being extensively used especially with installations of large boilers.

While cast iron, the usual material of which economizers are built, gives efficient and safe service for pressures now common, engineering opinion is not completely satisfied that it will do for pressures of 300 lb. and more. Steel is not so durable as cast iron for economizers, but with reasonable care it is safer for very high pressures. The whole economizer might be made of steel but for one chief reason; namely, the condensation of the vapors in the flue gas on the relatively cold tubes, resulting in seriously rapid corrosion of these tubes. This corrosive action is especially bad if the coal is high in sulphur. Cast iron withstands this corrosive action much better than does steel.

The use of steel for economizers is not new. Continental Europe used it for this purpose several years ago, and experience has confirmed that it corrodes much more rapidly than cast iron. However, if engineers are going to use boiler pressures up to 1000 lb., as is discussed, cast iron will not be safe. Just where it becomes unsafe—that is, at just what pressure—is a question which those interested in economizers would like to hear discussion upon. Those familiar with European experience with steel economizers are invited to write for publication in *Power*.

In a new power station now being erected for the Kansas City Light and Power Co., Sargent & Lundy, Engineers of Chicago, have met the economizer problem for a high-pressure installation in an interesting manner, by dividing the economizer into two sections, a high-pressure and a low-pressure section. The cold part of the economizer is of cast iron and will be operated at low pressure—only a little above atmospheric. The hotter part of the economizer is the high-pressure section, which is of steel construction something like a section of a Stirling boiler. The whole arrangement is as indicated in the drawing on the next page. The feed water will be pumped first through the low-pressure economizer into a tank which forms the suction tank for the boiler feed pumps by which it will be pumped through the high-pressure economizer and into the boiler. The economizers are so proportioned that the water will be heated in the low-pressure economizer up to not over 200 deg. F., probably between 170 and 190 deg., which will prevent the formation of steam in the low-pressure economizer and put the water into the high-pressure economizer at a temperature sufficiently high to prevent any condensation on the tubes of the high-pressure economizer. The condensation and consequent corrosion is thus confined to the low-pressure sections where leakage and deterioration are much more easily controlled.

The boilers are of the Babcock & Wilcox, cross drum, "Alert" type and are each 42 tubes wide, 14 tubes high with 20-ft. tubes all connected to one 60-in. drum. The boilers have 13,512 sq.ft. of heating surface each, and are rated at 1351 hp. Each boiler has a superheater designed to give 250 deg. F. superheat when the boiler is evaporating 90,000 lb. of water per hour. The working pressure is 300 lb. The chain-grate stokers are each 120 in. by 210 in. long.

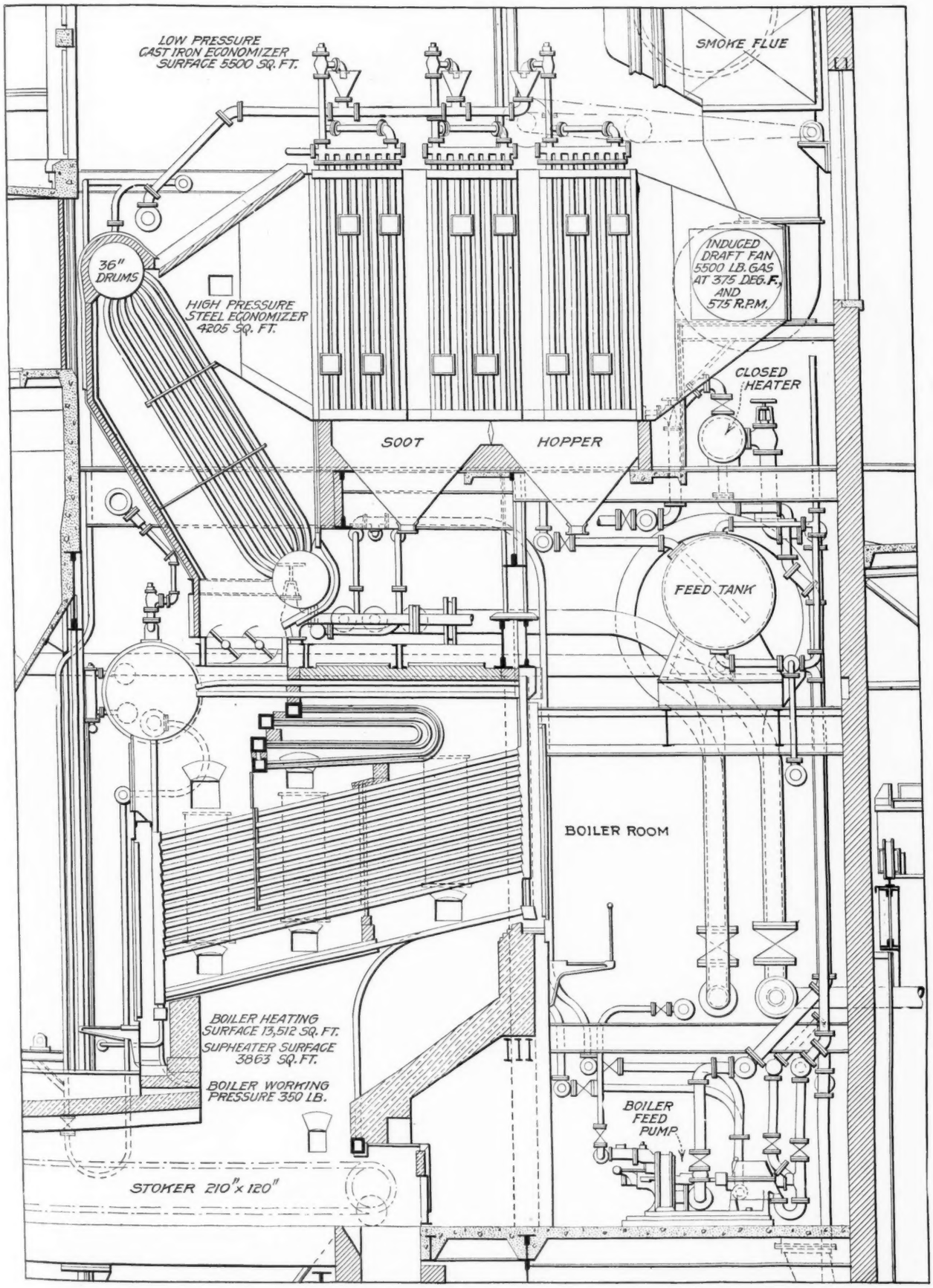
The high-presure economizer is made up of two 36-in. drums, 23 ft. long, having 306 3¼-in. cold-drawn seamless tubes ¼ in. thick, arranged in 38 sections of 8 tubes each, front to back. Each high-pressure economizer contains 4205 sq.ft. of heating surface. Notice that this economizer is baffled so that the gases pass over the tubes transversely three times. It is supported from the building steelwork, the support being at the upper end so as to be free to expand downward. The economizer is inclined 35 degrees.

Each low-pressure cast-iron economizer, of the Green type, has 336 12-ft. tubes, 7 tubes per header, with a total of 5500 sq.ft. of heating surface. Each economizer is 16 ft. 11 in. long and the outside over-all width is 16 ft. 2 in. The induced fans, one for each boiler unit, are of the multivane type, with two single inlets, driven by one 150-hp. slip-ring induction motor. Each boiler and economizer is intended to evaporate 80,000 to 100,000 lb. of water per hour, going up to 120,000 lb. per hour when forced.

Sargent & Lundy have one high-pressure all-steel economizer in operation and so far have experienced no difficulties from corrosion of the outside of the tubes. In this economizer the water has been kept at about 125 deg. F. entering the economizer, a heater being used to get the water up to this temperature. There are some evidences of corrosion, but it is expected that this can be kept down so that it will not be serious.

Each boiler has six soot-blower (Diamond) units on each side, with 21 nozzles to each unit; the high-pressure economizer has six units of 19 nozzles each.

The rotary system of oil-well drilling has been in common use only about 15 years. Its great advantage is speed in soft or caving ground.



HIGH- AND LOW-PRESSURE ECONOMIZERS, KANSAS CITY LIGHT AND POWER CO.

United States Nitrate Plant, No. 2

at Muscle Shoals, Ala.

CONDENSER EQUIPMENT

By Charles H. Bromley

CONDENSER INTAKE, SHOWING STOP-LOGS AND DISCHARGE TUNNEL

The 60,000-kw. unit has four condensers, each of 25,000 sq.ft. of Muntz metal tube surface. The circulating-water pumping capacity is 132,000 gal. per minute, 44,000 gal. per minute spare. A forebay with stop-log gallery constitutes the circulating-water inlet. The condensers, with 30 ft. 5⅞ in. long exhaust connections, are hung from the turbine foundation with no supports under the condensers.

THE 60,000-kw. three-cylinder, pure-reaction turbine is served by four surface condensers each of 25,000 sq,ft. of tube surface, two condensers being connected to each of the two double-flow low-pressure elements of the turbine.

An intake tunnel is not used, as is customary. A forebay has been created, as shown in the headpiece. The water from the river enters the forebay via the stop-log gallery, Fig. 2. Each of the eight inlet openings in the gallery has a front resting on two tanks and which floats up and down with the rivel level, guides for the float being made in the concrete piers. Section and plan views of one of these floats are shown in Fig. 7. The concrete piers have a total height of 21 ft. each up to the floor or walk level; all concrete used in its construction is of 1:2½:5 mixture. Practically all the wood used is creoseted yellow pine. Each pier is 3 ft. thick and the distance, in the clear, between piers is 8 ft. The stop logs are 1½ by 10 inches.

The purpose of the floats is to draw water into the forebay from about 3½ ft. beneath the surface of the river and thus provide a means of keeping floating débris out of the forebay.

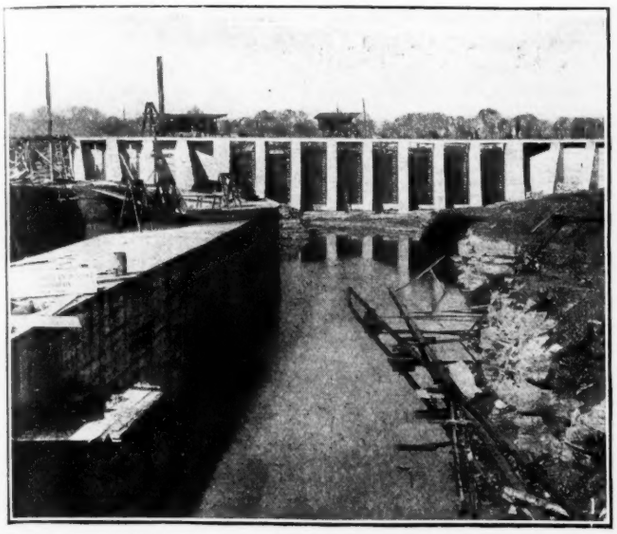
Because of the filled-in bank on the upstream side of the forebay the tendency is to cause the river current to throw floating débris out into the steam and clear of the stop-log gallery.

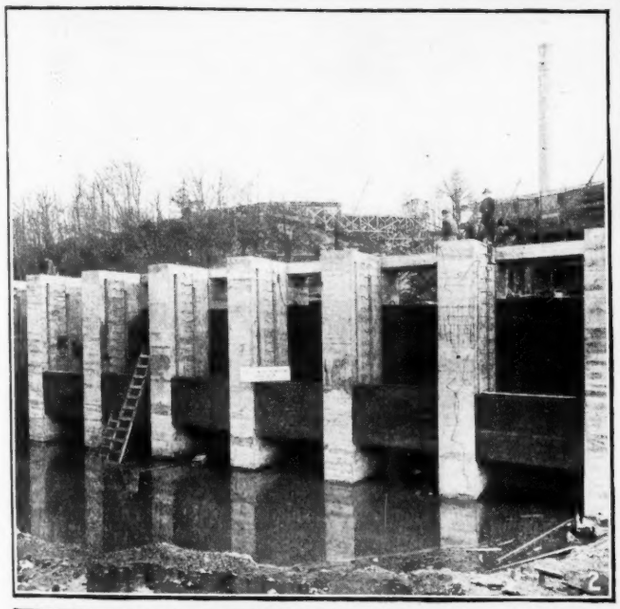
At the power house are six 78 in. wide, vertical, traveling screens. Fig. 4 shows their location. Each screen is 6 ft. 4¼ in. wide between centers of the chain, 45 ft. long between centers of head and foot shafts; these operate at a speed of about 9 ft. per minute. They are made up of continuous screen trays 78 in. wide, 18 in. pitch, mounted on two strands of 18-in. pitch steel bar link, bronze-bushed roller chains with solid iron rollers. The screen trays are made of angle-iron frames with No. 18 U. S. S. gage galvanized steel wire cloth with ½-in. clear openings.

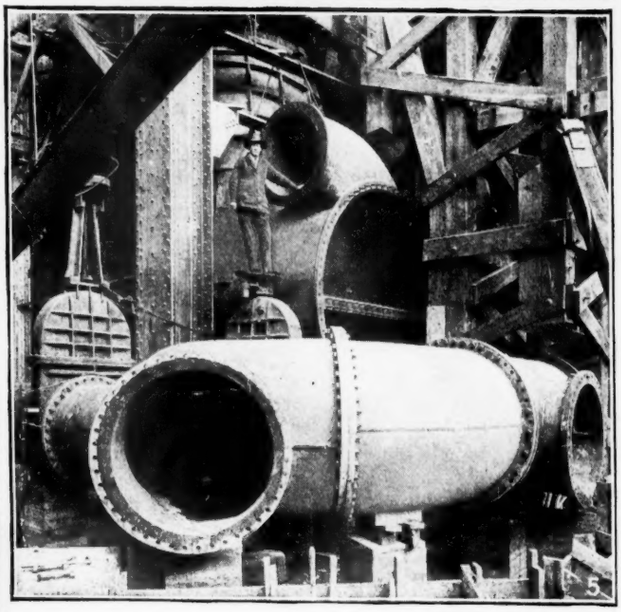
The six screens will pass 515 cu.ft. of water per second at a water level of 12 ft., based on a velocity of 2 ft. per sec. The six screens are driven through a common lineshaft with jaw clutches by two 10-hp. motors running at 865 r.p.m. The headshafts are driven from the lineshafts by bushed-roller chain drive through incased speed-reducing transmission at each end of the lineshaft with flexible couplings to the motors. Each speed-reducing transmission is connected to the lineshaft through spur gears having breaking-pin hubs. The total weight of the screens is 131,000 pounds.

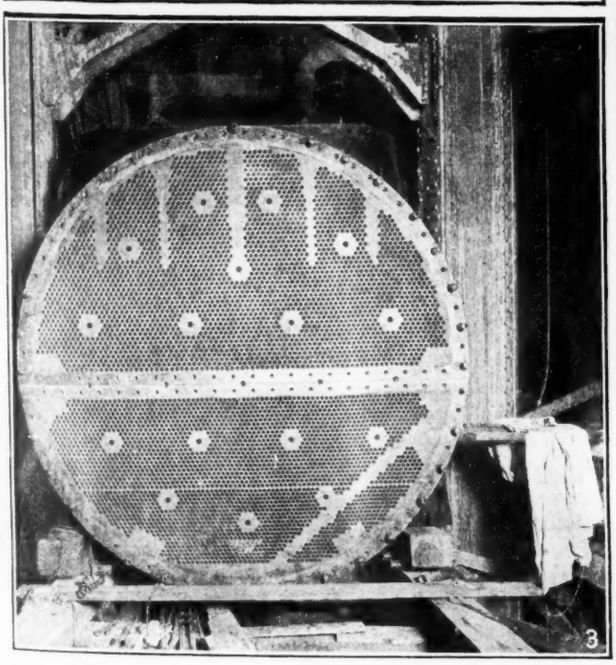
Four centrifugal circulating pumps, each driven by a 550-hp. motor at 700 r.p.m. have capacity of 44,000 gal. per minute each, total 176,000 gal. per minute, or 87,964,800 lb. per hour at 60 deg. F. One of these pumps is a spare. This will mean a flow of about 400 c.f.s. in the intake. The level of the intake water below the discharge-water level is 3.5 ft., and the level of the cold well below the center line of the pump is 15 ft. The total pumping head, exclusive of pumping head through the condenser, is 9 feet.

The intake tunnels and wells in the station are so









FIGS. 1 TO 5. INTAKE, CONDENSER HEAD AND SOME OF THE 60-IN. PIPING AT MUSCLE SHOALS

Fig. 1—Looking down the intake toward the stop-logs; the discharge tunnel is shown at the right. Fig. 2—The stop-logs from the river side; note the floats which skim off the floating débris. Fig. 3—Showing the tube sheet of the condenser. Fig. 4—Close-up view of the concrete structure for the revolving screens; note the man at the left. Fig. 5—Showing part of the condenser and the 60-in. circulating-water piping.

Photographs by courtesy of J. G. White Engineering Corporation.

arranged that they may be conveniently flushed and cleaned. The arrangement of the pumps is desirable from the operating viewpoint particularly, as shown in Fig. 6, which gives the important dimensions.

Rubber expansion joints are used in the circulating-water piping to care for distortion. A hoist is provided over each circulating pump to lift off the cover with facility.

The air pumps are of the LeBlanc type, each of 2000 gal. per minute water; the discharge head including friction is 4 ft., and the suction lift including friction is 10 ft. The pumps are each driven by a 100-hp. motor at 700 r.p.m.

Condensate pumps have capacity for 400,000 lb. per hour, each at head of 96 ft., with a submergence head of 3½ ft. Each is driven by a 75-hp. motor at 1750 r.p.m.

and Cincinnati, Ohio, where similar conditions obtain.

The condensers will give the following performance:

When condensing 400,000 lb. of steam per hour:

Temperature of Water. Deg. F.	Vacuum, In.
80	28.45
60	29.15
40	29.30

When condensing 500,000 lb. of steam per hour:

Temperature of Water, Deg. F.	Vacuum, In.
80	28.30
60	29.05
40	29.25

When condensing 600,000 lb. of steam per hour:

Temperature of Water, Deg. F.	Vacuum, In.
80	28.15
60	29.00
40	29.20

The manner of supporting the condensers was given

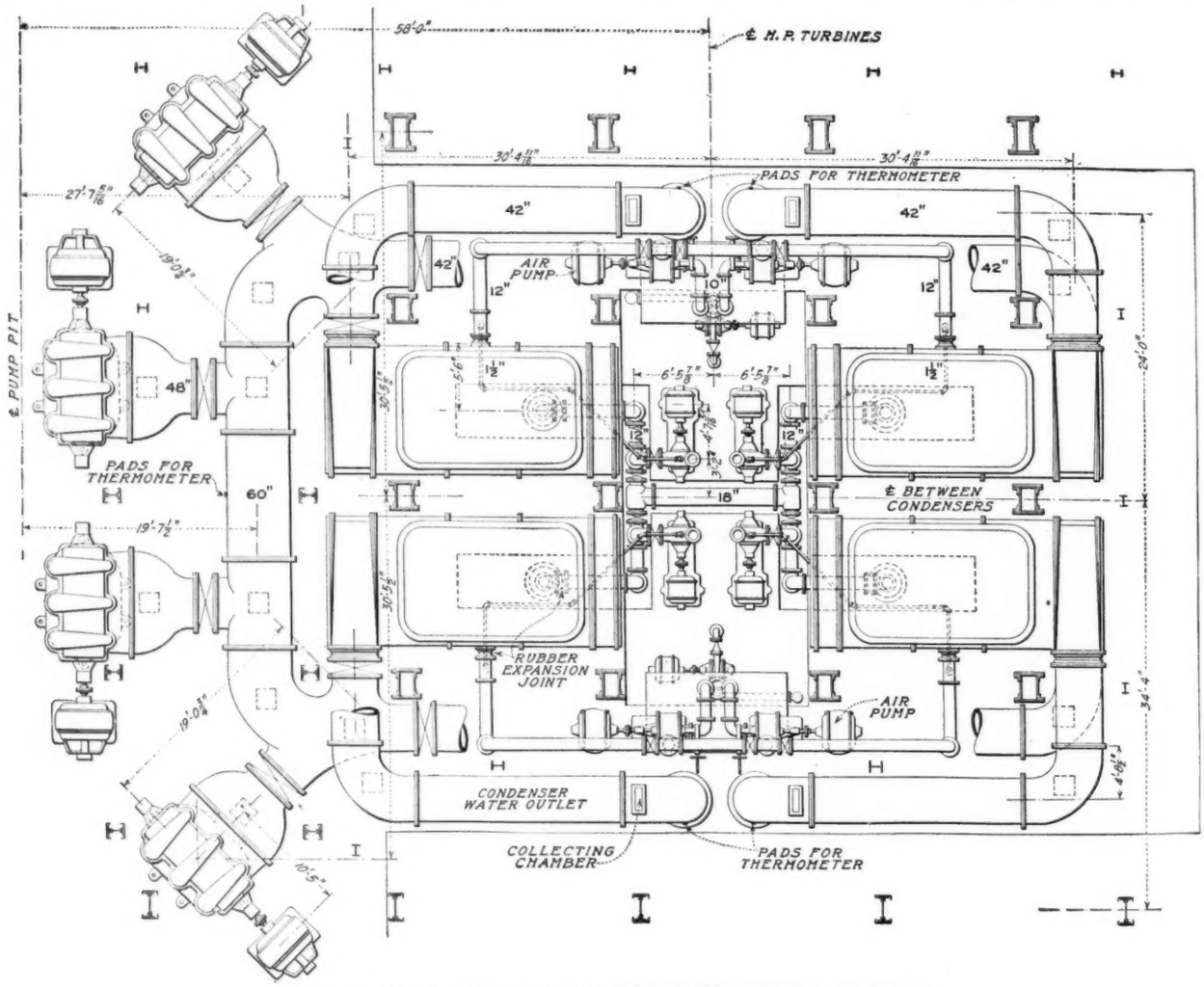


FIG. 6. PLAN OF CONDENSER PIPING, CONDENSERS AND PUMPS

There are four 25,000 sq.ft. condensers served by four circulating pumps (one a spare), each of 44,000 gal. per min. capacity, discharging into a ring supply pipe common to all four condensers.

The four 25,000-sq.ft. condensers have 5285 1-in. Muntz-metal tubes each, 18 ft. 3⅜ in. long, arranged in the heads as shown in Fig. 3. The weight empty is 220,000 lb.; full of water, 405,000 pounds.

The condenser inlets are 31 ft. below flanges of the exhaust openings of the low-pressure elements, the castings forming these steam passages being so well done as to call for commendation. The losses in these passages will likely be negligible, basing judgment on performances in the large plants at Windsor, W. Va.,

unusual consideration jointly by the purchaser, the J. G. White Engineering Corporation, the turbine designer and the condenser builder. The condenser and connecting steam passage are hung from the turbine foundation, being keyed to hanger girders at all four sides with keys 26½ in. long, 4 in. wide, 2½ in. thick, of forged steel and made to conform to the A.S.T.M. specifications. There is an expansion joint between the exhaust connection and the turbine exhaust to provide principally for expansion along the tubrine

axis. The exhaust connection pieces are supported by steel straps suspended down from the steel work of the turbine foundation. The condenser is suspended from the exhaust connection and there are no supports beneath the condenser.

The next article deals with heat-balance studies of the station and is accompanied by numerous curves giving

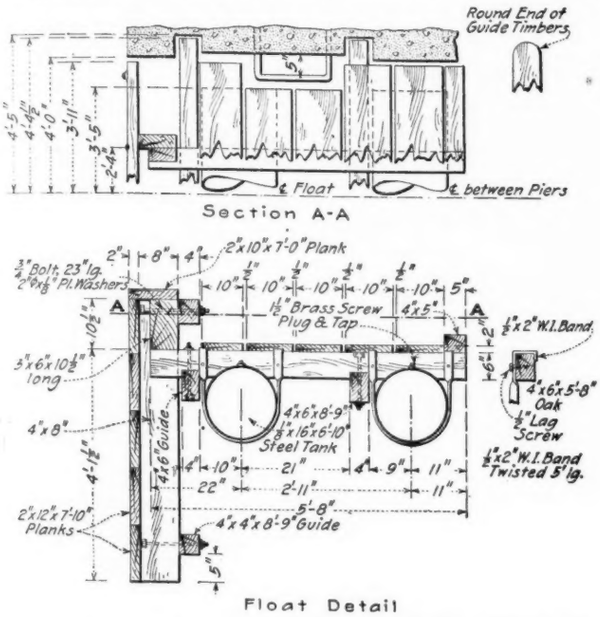


FIG. 7. DETAILS OF FLOAT USED IN THE STOP-LOG CONSTRUCTION

all the data that the consulting, designing and operating engineers desire. The article was prepared for *Power* by W. A. Shoudy and H. C. Lockwood, of the Mechanical Division, J. G. White Engineering Corporation, who built the station.

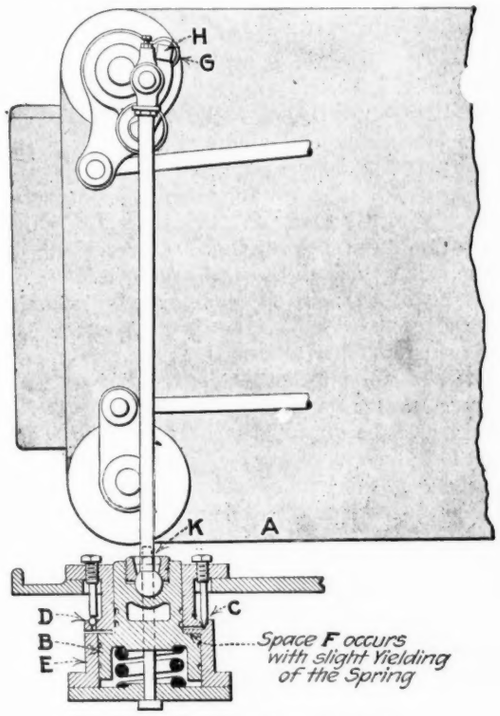
Miller Vacuum Dashpot

A type of Corliss valve gear coöperating with a vacuum dashpot, having certain new features perfecting the operation of a Corliss engine for the requirements of high speed, high pressure, long range, and close regulation, has recently been patented by F. B. Miller, 25 South St., New York City. The advantages with such requirements are, for example, a direct-connected generator furnishing current for the lighting and elevators in an office building. The size of the generator and that of the engine are reduced by having high-speed, high-pressure and long-range cutoff, thereby reducing the floor space required and the first cost. Close regulation is necessary to avoid flickering of the lights due to fluctuation in load caused by the operating of elevators.

A brief description of the construction and operation of the dashpot follows: *A* represents the engine cylinder. When the dashot plunger is released and the air that is taken in through the air valve *C* is discharged through the check valve *D*, which is adjustable, the piston *B* will take the thrust noiselessly and without rebound, owing to the air cushion and to the slight yielding of the spring, shown in the chamber of *E*, which is not more than $\frac{1}{16}$ in. at the maximum. The spring is of a heavy, durable type, not subject to great changes, and should give no trouble. It is obvious that all the air cannot escape through the check valve *D* instantly, therefore a portion is compressed in the chamber of *E*, caused by the slight yielding of the spring. This air forms a cushion for reseating the movement of the piston *B*, and at the same time the air is given a period in which to escape, and disposing of the air under the piston means a particularly high vacuum or the maximum atmospheric pressure on the face of the plunger regardless of whether the lift is $\frac{1}{16}$ in. or to the maximum.

Should there be, by reason of poor adjustment, a slight space between the piston and the plunger, this is mechanically eliminated by having a type of valve gear with the clearance at *G* reduced to a minimum (about $\frac{1}{64}$ in.) This small amount of clearance is made possible by having a dashpot spring, which serves as a preventive against breaking any member of the valve gear. Therefore it is not necessary to make allowance for the expansion of the engine cylinder, for dirt or poor adjustment.

The conditions mentioned are favorably affected as follows: With a high speed with the long-range gear cutting off at the maximum, the period of cutoff is very short; this is accomplished by reducing the radius *H* to a minimum, thereby reducing the lift of the dashpot



SECTION THROUGH DASHPOT

plunger, which means a shorter period required for complete cutoff. The long-range valve gear cutting off at the minimum, the lift of the plunger is slight; having the maximum atmospheric pressure on the face of the plunger regardless of the lift, the friction on the steam valves is overcome. The complete cutoff of the steam takes place more rapidly and positively regardless of the variation of the load on the engine, thereby avoiding leaky valves and poor regulation. It is evident that the positive seating of the vacuum-pot plunger will permit a smaller lap with the result that less angular advance is needed.

Therefore this means a greater range of cutoff under control of the governor and a corresponding increase in horsepower.

Instrument Voltage Transformers

By W. R. Woodward,
General Engineer, Westinghouse Electric & Mfg. Co.

WHEN the line pressure is 250 volts and less, it is common practice to wind the voltage coil of the measuring instrument for line voltage. It is obviously not practical to wind and insulate instrument coils for voltages higher than 750 volts, so a voltage transformer is necessary to reduce the pressure to a lower value. The transformer thus serves as a safety barrier by keeping the high voltage away from the instrument and also makes it possible to standardize on instruments of a single voltage range. The voltage transformer is similar in construction and application to a small power or distribution transformer, its secondary load being the windings of the instruments or meters to which it is connected. The high-voltage winding is connected to the wires whose difference in potential it is desired to measure. This difference in potential, or voltage, causes a current to flow through the high-voltage winding. The amount of current that will flow depends on a number of factors, such as the value of the voltage, frequency, number of turns and quality of iron in the transformer. The current will be just sufficient to produce the proper magnetic flux in the transformer iron to generate a back, or reversal, voltage approximately equal to the applied voltage. This flux is, of course, pulsating or alternating the same as the applied voltage, and thereby generates or produces a voltage in any other winding that may surround the core. The value of the voltage so produced depends directly upon the relative number of turns with respect to the primary windings, so that the secondary voltage equals the primary voltage divided by ratio of primary to secondary turns. If the primary has 4000 turns and the secondary 200, their ratio is 20:1 and the secondary voltage is one twentieth of the primary. The foregoing is not strictly correct, as in order to get greater accuracy a few primary turns are omitted to compensate or make up for the small losses in the transformer. This compensation is usually about one-half of one per cent. When the transformer is not connected to its secondary load, the secondary voltage is usually higher than its ratio indicates, but when carrying its proper load the ratio of primary to secondary voltage should be correct as marked on the nameplate.

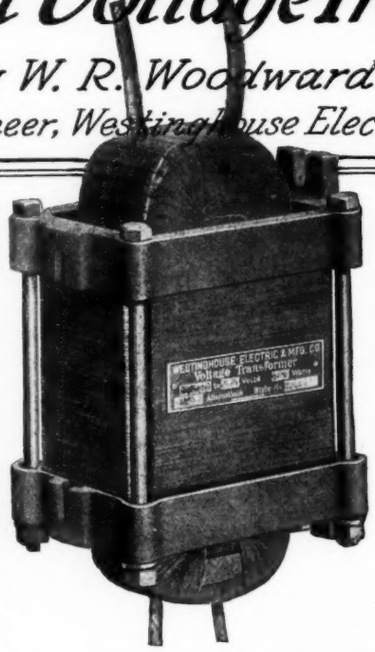


FIG. 1. DRY-TYPE TRANSFORMER

Fig. 4 shows a cross-section through a typical voltage transformer. H_v is the high-voltage winding, well insulated from the iron magnetic circuit F and low-voltage winding L_v. Any flux set up by the magnetizing current flowing in the primary coil H_v will follow the iron circuit on account of the very high permeability of the iron, and will therefore pass through L_v the low-voltage coil also. This form of construction is commonly used for dry-type transformers for voltages up to 3000 or 4000. A voltage transformer of this type is shown in Fig. 1.

Fig. 5 gives a different arrangement of coils. This form is adapted for a higher voltage—from 5000 to 10,000 volts. It will be noticed from the figure that two high-voltage coils H_v and two low-voltage coils L_v are used. This type is usually mounted in an oil-filled tank, as in Figs. 2 and 3. Using two coils cuts down the voltage per coil and thereby makes it easier to insulate. For still higher voltages the core-type form shown in Fig. 6 is best adapted. The low-voltage winding is placed close to the core and insulation barriers, in the form of tubes, placed between it and the high-voltage coils. The high-voltage winding is broken up into a number of coils, as indicated, in order to keep the voltage stresses down. This type of construction is especially well adapted to voltages of 15,000 or 20,000 and up as high as voltage transformers are built. Fig. 2 shows an outdoor voltage transformer for use on a 20,000-volt circuit and Fig. 3 an outdoor-type of voltage transformer for

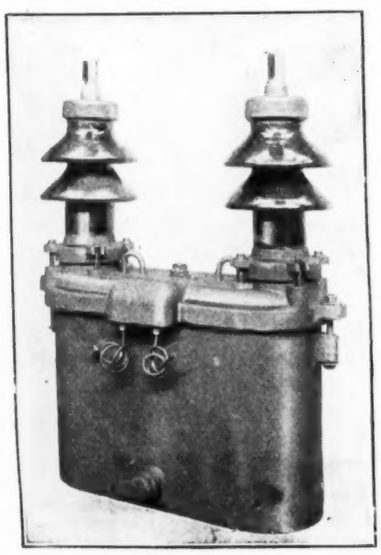


FIG. 2. OUTDOOR-TYPE 20,000-VOLT INSTRUMENT TRANSFORMER

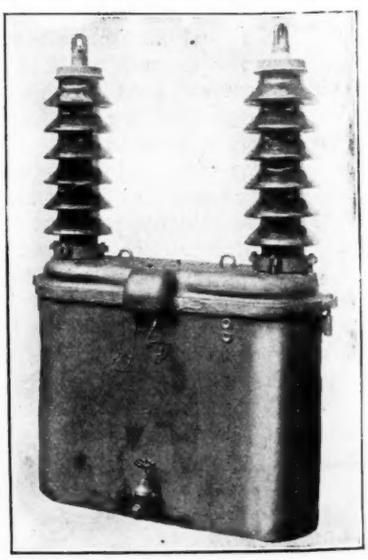


FIG. 3. OUTDOOR-TYPE 70,000-VOLT INSTRUMENT TRANSFORMER

70,000 volts. For the higher voltages a choke coil is sometimes connected between the transformer windings and the high-voltage leads. This coil is solely for protection against lightning and high-frequency disturbances. If a high-frequency surge comes down the line, when it tries to pass into the transformer it meets a very high

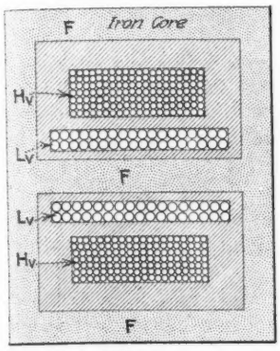


FIG. 4

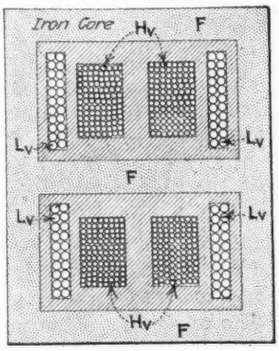


FIG. 5

FIGS. 4 AND 5. SECTIONS THROUGH SHELL-TYPE TRANSFORMER

impedance in the choke coils and is forced to pass down the line, where it can be safely conducted to ground by the protective apparatus. Of course a high voltage is built up across the choke coil, but it is specially insulated between turns for this condition, and even in case of failure between turns of the choke coil, the transformer will still operate without error. If the break were in the high-tension winding of the transformer, it would burn out immediately. The choke coil has no effect at normal frequencies, as its impedance varies directly with the frequency, therefore offers little opposition to the flow of current at normal frequency, but it offers great opposition to lightning disturbances of very high frequency.

If the secondary terminals of a transformer are connected to an instrument or meter, a current will flow through the meter. This current flowing through the secondary winding tends to oppose the flux in the core or to demagnetize the core. This tendency is immediately counteracted by a current which will flow in the opposite direction through the primary winding. It is a

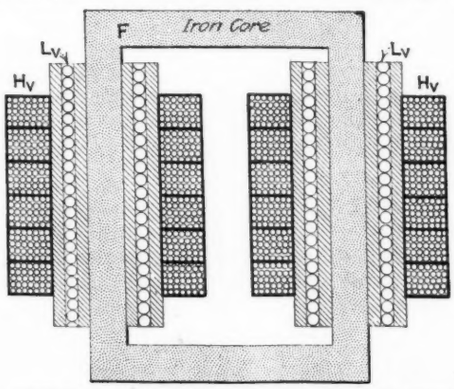


FIG. 6. SECTION THROUGH CORE-TYPE TRANSFORMER

fundamental law of the transformer that neglecting the exciting current, the primary current is equal to the secondary current divided by the ratio of primary to secondary turns; or another way of expressing it is to say that the primary and secondary ampere turns are equal but have opposite directions around the magnetic core.

In connecting instruments in which both current and potential are measured as in a wattmeter, a definite relation must be maintained between the current and potential. If either current or potential wires are reversed, the meter will not read correctly. For this reason it is necessary to know the relative direction of current in primary and secondary leads.

Referring to Fig. 7, the arrows show the relative direction of currents in the leads and windings. In tracing a lead on a diagram, the line A to X may be followed as indicated by the large arrow, just as though the transformer did not exist. In checking the actual wiring, however, it is necessary to know which two leads correspond to those marked A and X in the diagram. It is customary for the manufacturers to designate these two leads with a distinguishing mark such as white paint or tape. The marked leads bear the relation to each other as indicated for leads A and X; that is, "ingoing" current in the primary "marked" lead gives "outgoing" current in the secondary "marked" lead.

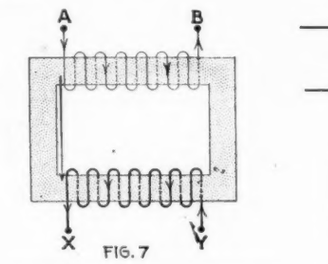


FIG. 7

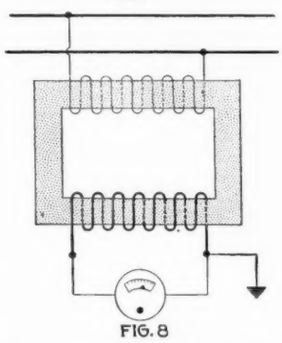


FIG. 8

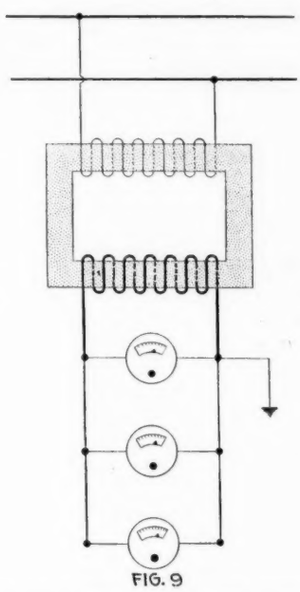


FIG. 9

FIGS. 7 TO 9. TRANSFORMER CONNECTIONS TO MEASURE VOLTAGE ON A SINGLE-PHASE CIRCUIT

Fig. 8 represents the connection of a transformer to a single-phase line and to a single instrument. If several instruments are to be connected to the one transformer, they are connected as shown in Fig. 9; that is, the instrument coils are all put in parallel across the secondary leads of the transformers. The total current flowing through the transformer secondary winding will be the sum of the currents flowing in all instruments so connected.

The most common connection on three-phase circuits is that of two transformers in open delta, Fig. 10, by which the voltage on all three phases may be measured. Since the transformer No. 1 is connected from A to B, meter A will measure to voltage between these two conductors. Transformer No. 2 is connected from B to C, consequently meter B will indicate the voltage between the two conductors. Meter C is connected across the secondaries of transformers Nos. 1 and 2; however, the relation between the voltage of these two transformers is such, when connected to a three-phase circuit, as in the figure, as to give the voltage between A and C di-

vided by the transformer's ratio. Therefore, meter *C* will measure the voltage between conductors *A* and *C*, just as it would if connected to transformer No. 3. If the voltages are balanced on the high-voltage side, instruments *A*, *B* and *C* should read the same.

In case of three-phase four-wire circuits it is common practice to connect the primary of the transformers from outside wires to neutral, and in order to measure all voltages, this requires three transformers connected in star on the high-tension side. It is usual practice to also connect the low-tension in star. The three-phase voltages between *X* and *Y*, *Y* and *Z* and *X* and *Z* are the same as between *A* and *B*, *B* and *C* and *A* and *C* except on a small scale. If it is desired to know the voltage from *A* to *B*, a meter placed across *X* and *Y* will give this value divided by ratio of turns of primary to sec-

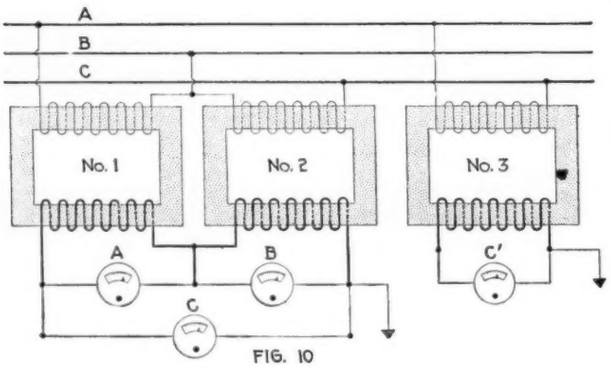


FIG. 10

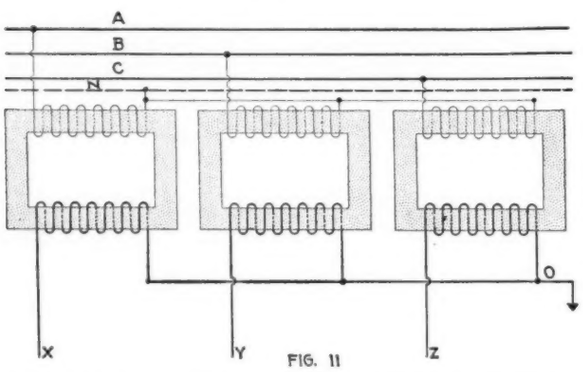


FIG. 11

FIGS. 10 AND 11. TRANSFORMER CONNECTIONS TO MEASURE VOLTAGE ON A 3-PHASE CIRCUIT

ondary in the transformers. Also a reading from *X* to *O* will indicate the voltage from *A* to *N*, etc.

It will be seen that the secondaries of all the transformers are ground; in fact, every secondary network should be grounded. This serves to drain off any static charge the instrument may take due to condenser action of the primary and secondary windings. Also in case of failure of insulation between high-voltage and low-voltage windings, the high-tension current will flow to earth through this ground instead of through some other path, which might be from the winding of the instrument to its case and then through the attendant to ground. Either or both the instrument and attendant might thereby be injured. As a safety-first rule the secondary circuit should always be well grounded.

An oil well has been defined as a hole in the ground, a quarter of a mile deep, into which a man may put a small fortune or out of which he may take a big one—he never knows which until the hole is finished.

Trouble with Scored Fuel-Valve Seat

By D. L. Fagnan

Melting out of exhaust valves at heavy load and a smoky exhaust causing complaints from a near-by hotel and business block were the conditions that demanded the services of a troubleman versed in the ways of Diesel engines, and it was my luck to draw the job. Conversation with the engineer brought out the fact that there had been a smoky exhaust on this engine ever since he had taken the position and that the fuel nozzles and all valves needed considerably more grinding in than any other Diesel he had ever operated. He said that the pressures carried were higher than was good practice because the engine seemed to require such pressures for good running, but he never could obtain a clean exhaust. These facts gave me a clue as to where to look for the trouble.

The engine used too much fuel per kilowatt-hour, as shown by the notes and record of the plant. Within perhaps one week of operation after an overhauling the atomizers would stop up with carbon, the fuel nozzles would stick open, and before the load could be transferred to one of the other engines, a large hole would be found burnt through the exhaust valve, causing havoc generally. The engineer had tried nearly every means to locate and remedy the trouble and put the problem up to me.

Many articles relating to Diesel-engine troubles and their remedies appearing in the mechanical papers had come to my notice. My memory informed me that a somewhat similar case had been recorded, but my back copies were destroyed and there was no way of finding out the paper in which it had appeared. However, I knew the trouble had been found in the fuel nozzles and so these claimed my attention. The fuel needles were carefully examined and found to need slight regrinding. The seats were hard to examine as they were deep in pockets; so a soft-pine stick was cut to about the same shape as the fuel nozzle, and the ends were sandpapered true and smooth. By striking this stick repeatedly but lightly with a hammer, a good impression of the nozzle seat was obtained. By the use of this device, two small grooves were found in one seat and three in another, the third being in good condition.

The engineer said that No. 2 cylinder had given no trouble from burnt exhaust valves, but that Nos. 1 and 3 had caused all the mischief. It was the nozzle seat on No. 2 cylinder that was not scored or grooved. About fifty miles from this plant an erecting man from a different company was installing Diesel engines, and I rushed there to see whether a reamer could be obtained, taking a fuel nozzle with me. Luckily, they had a reamer which had been obtained from the shop for just such a job. This was borrowed and used to good advantage. The fuel needles were ground in, and on testing out the seats were found to be perfect. When the engine was started up, the exhaust was clear and no further difficulty was experienced. A reamer was ordered sent from the factory for future emergencies of like nature, but so far no use has been found for it.

It would be hard to guess how this fault would have been located if it had not been for my reading about some engineer overcoming just such a trouble. His sending his experience to a technical journal proved a blessing, for this is such an unusual trouble that one could be excused if he did not find it.

Overcoming Blow-off Valve Troubles

By PHILIP ECKENROTH

IF THE service conditions of blowoff valves were analyzed, it would be found that the most serious element is the accumulation of scale against the seating surfaces when the valve is shut, as shown by Fig. 1. This deposit is pressed firmly against the seating surfaces of the plugs or moving members and has the effect of a

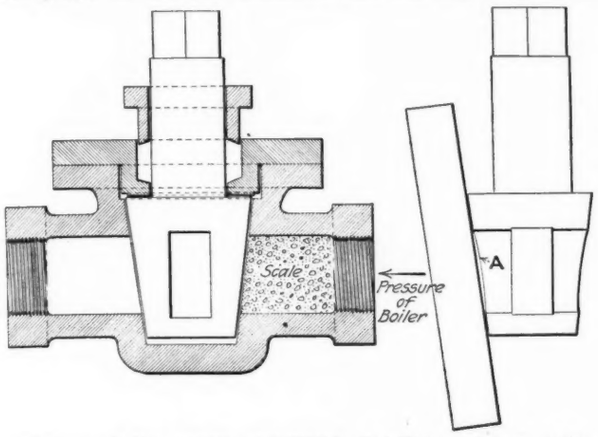


FIG. 1. PLUG COCK SHOWING BANKED SCALE AND WORN PLUG

stick of emery with the boiler pressure as a lever pressing against it. And the harder the scale and the more the valve or cock is operated, the quicker the surfaces are destroyed.

If a straight-edge is placed on a badly worn plug, one can see between the plug and the straight-edge at about the opening through the cock, as at *A*. The same effects are produced where surfaces are moved with the scale bearing against surfaces, as in gate valves, etc.

This causes the valves to score in the direction of their line of travel and produces leaks in a short time. Therefore, in order to prevent leaks it will be necessary to arrange the seating surfaces of plug cocks or plungers of seatless valves so that the scale will not be pressed against them, as no means are provided for taking care of this wear.

Blowoff service is regarded as the hardest to which a valve or cock can be subjected, and after an experience of over 25 years as a repairman of such, and after trying about every valve and cock on the market and watching the results of other engineers, I came to the conclusion that to obtain good service from such valves it would be necessary to design one that could use the scale and mud as a medium for keeping the seating surfaces in shape.

This might at first look like a hard proposition, but it proved simple after a little experimenting, although it required a complete change in valve design and operation in order to have a better valve after two years of use than at the start so far as the seating surfaces were concerned.

In order to obtain this result it is necessary to have a close-grained cast-iron disk with a bronze or monel-metal seat; a rotation of the disk on the seat after it comes in contact with the seat; seating surfaces held together by a resilient means during the operation of closing the valve, using the scale and mud to keep valve seats in shape. The results of this combination are surfaces that can be matched only by a grinding machine operation. When one can produce better seating surfaces in a valve after two years' use than when it was new by the simple means of opening and closing it, that is a valve that will stay on the job as long as there is a piece of the disk or seat left.

Such a design of valve is used with boilers that are operated 24 hours daily, 300 days a year.

This valve, shown in Fig. 2, differs from others in that it has a floating yoke *A* separated about $\frac{1}{4}$ in. from the washers *B* by means of springs. The valve stem *C* has a square end that fits into a square hole in the disk *D* and is held in place by the nut *E*.

When the stem *C* is turned, the disk *D* turns with it, and when closing the valve after the disk *D* comes in contact with the seat *P*, it continues to rotate until the floating yoke *A* comes in contact with the washers *B*. Then the springs cease to be of any value and are virtually out of service, thus practically making a solid construction of the yoke and yoke studs. Moving the lever *G* in the reverse direction to the motion of the handwheel gives a firm seating and also acts as a lock and prevents any movement of the handwheel until it is released by the lever. The lever *G* can be used for reseating the valve while in service if necessary.

If the handwheel is screwed down until the disk *D* comes in contact with the seat *P*, using a little pressure to keep the seating surfaces together with the aid of the

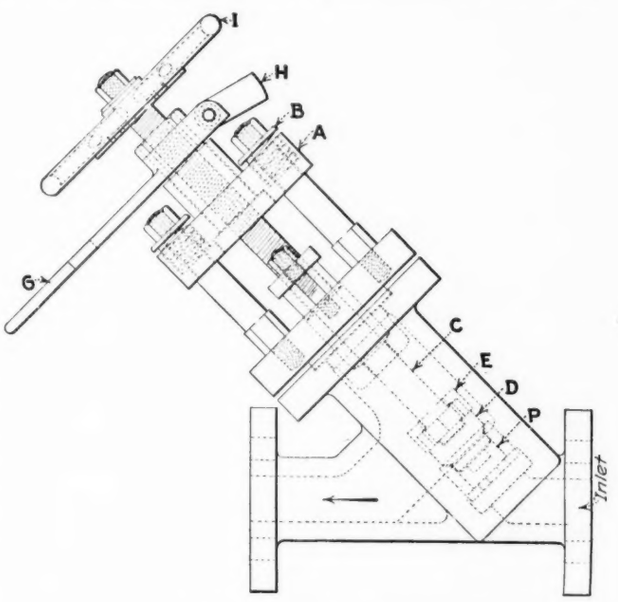
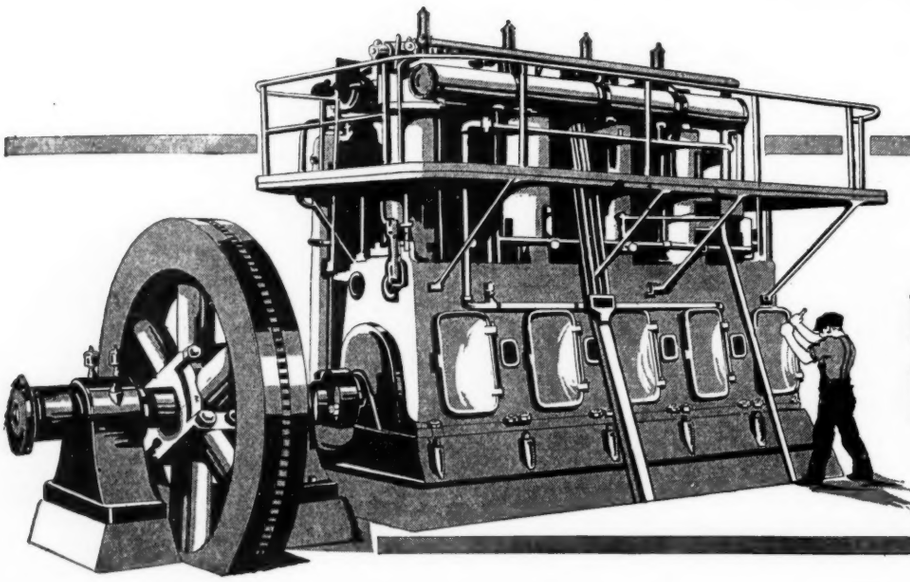


FIG. 2. DETAILS OF THE BLOWOFF VALVE

springs interposed between the yoke *A* and the washers *B*, and throwing pawl *H* up until it comes in contact with one of the spokes of the handwheel, the disk can be rotated on its seat while the valves are in operation. In this way the valves can be kept in service as long as there is a piece of the disk and seat left.

This means years of use without leaks and repairs, and this valve has made a hard problem easy. It is patented but it is not for sale. We make it for our own use.



Talks on DIESEL Engines

by L. H. Morrison

XIII—*Governors and governor troubles form the subject of the chief's talk, after he announces the cheering news of a general increase of pay.*

THERE was air of lightness and cheerfulness in Egan's manner as he came into the engine room, and so the men rightly suspected that he had something of unusual interest to tell.

"It has always riled me that the men in the turbine plant drew more money than we did, because I felt that our cost per kilowatt-hour was low. Last week I had a chance to compare the Diesel and the turbine costs, and ours were a shade lower, and ever since I've been working for a raise. While I was at supper the supervisor 'phoned and told me we'd all been given a raise of five iron men a week."

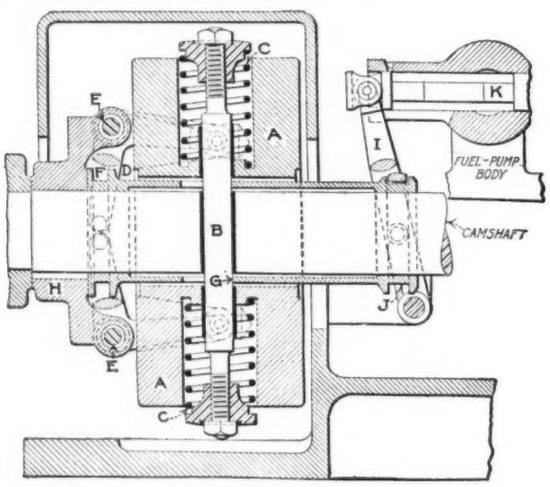


FIG. 1. GOVERNOR OF McEWEN ENGINE

The buzz that followed this announcement just escaped being a cheer. While it was subsiding, Egan opened his desk, took out his sketches for the evening's talk, and seated himself at the table.

"After discussing fuel pumps," he said, "the next detail that would naturally follow is governors. This sketch, Fig. 1, shows a cross-section of the McEwen engine governor. Two weights *A* are held together by the spring bolt *B*, which passes through the camshaft. When the camshaft rotates, the weights are moved outward by centrifugal force against the resistance of the springs *C*. Each weight is connected to one arm of a bell-crank lever *D* pivoted at *E* and the other arm of the lever carries a pin that fits in a groove *F* in the loose sleeve *G*. The collar *H* carrying the pins *E* is keyed to the camshaft. When the engine speed rises, the outward movement of the weights is transmitted to the bell cranks and moves the sleeve to the right. The lever *I*, which has a pin fitting in the groove *J*, is thus swung to the right, moving the wedge *K*, which

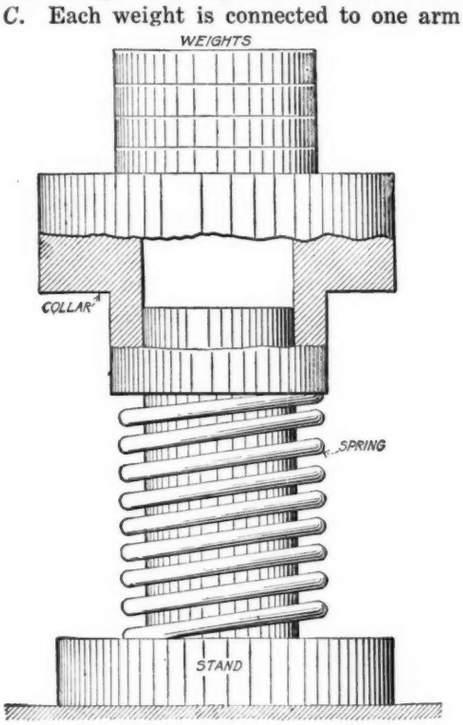


FIG. 2. STAND FOR TESTING GOVERNOR SPRINGS

In the next article the subject of the chief's talk will be the supplying of high pressure air for the injection of the fuel charges

shortens the suction stroke of the fuel pump. This type of governor is ideal for small engines. It is simple, easily adjusted and has few pivots, so there is little lost motion due to pivot wear. However, it's practically impossible to get the two governor springs alike. The result then is that one weight will move out farther than the other, causing binding between the governor weight levers and the sliding sleeve."

"Well, chief," the ever-inquisitive Woods asked, "how can you judge if the springs are alike?"

"In the ordinary plant it's not easy to do, but you can get a fair idea by turning up an iron or brass stand and collar, such as this (Fig. 2)," Egan said, rapidly outlining his idea. "Then by placing weights on the collar or table and measuring the deflection of the springs at various loads, any great difference will show up. It's surprising how springs will vary. If I had my way, all the valve springs on an engine would be made from the same bar of spring stock. Then I'd insist that all must be hardened at exactly the same temperature. I've heard many an engine damned because of too weak or too strong governor and valve springs.

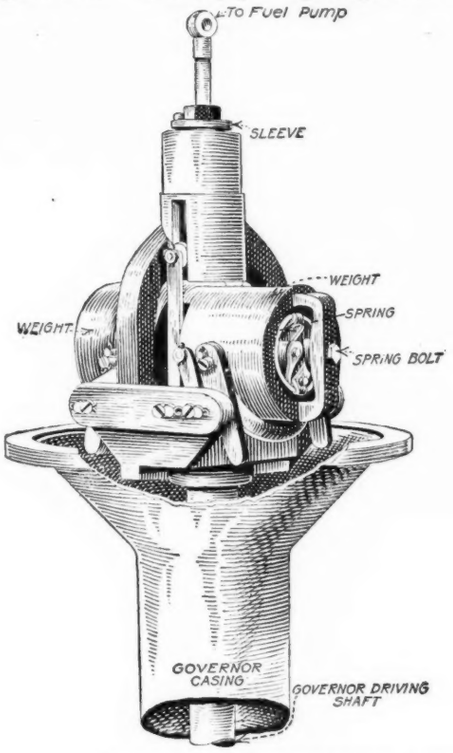


FIG. 3. GOVERNOR OF ALLIS-CHALMERS ENGINE

"But that's enough of springs. Now let's take up Fig. 3, which shows the governor used on the Allis-Chalmers engine. It has only one spring between the two weights, is very accurate in governing and has no more wearing parts than a good design demands. One very desirable feature is that it revolves at considerably above engine speed, which allows lighter governor weights to be used than if run at the speed of the engine. Of course, the lighter the weights the less the wear at the pivots.

"It's generally conceded that a governor should be well lubricated, but it has been difficult to do this without having the oil thrown off by the revolving parts. This has been prevented in this design by inclosing the governor in an iron case. The lubricating oil enters the top and the entire mechanism is in a bath of oil.

"The next governor that I've thought worth our while is the Jahns, which, with modifications to suit it to the particular engine, is used by the National Transit Co., the Busch-Sulzer Diesel Engine Co. and the Snow Co. In the National and Snow engines the sliding collar is below the governor, while in the Busch engine it is above the governor. This modification has no effect on the working, being merely a convenience in attaching the fuel-pump mechanism.

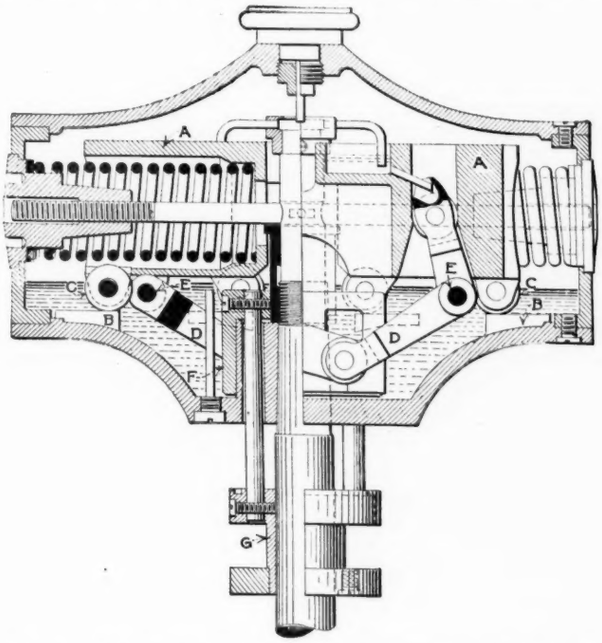


FIG. 4. JAHNS GOVERNOR USED ON NATIONAL ENGINE

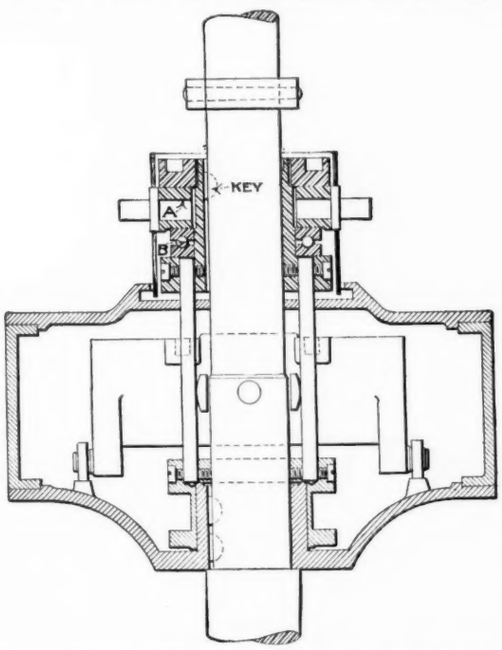


FIG. 5. JAHNS GOVERNOR USED ON BUSCH-SULZER ENGINE

"Fig. 4 shows a sectional view of the Jahns governor used on the National engine. It governs the fuel charge

by controlling the time of closing of the suction valve. One of its most admirable features is the use of a speed regulator."

"What changes of speed can you get?" Kelly inquired.

"With this type of regulator, a variation of 5 per cent. up and down from normal."

"Then I can't see much good in it," Kelly declared.

"You are wrong there, Kelly. Only a small speed variation is wanted. In a flour-mill drive it's highly desirable to give the lineshaft the proper speed, but the variation won't be over 3 per cent. Take our power plant here. When we run in parallel, if our engine speeds are not the same, the fast one will pull enough of the load to bring its speed down to the other. This means one unit is loaded while the other is comparatively idle, and so we need a regulator to split up the load. It isn't often that a correction of more than 5 per cent. is necessary. The striking feature of the Jahns governor is that the weights *A* do not swing on pivoted arms but move in and out on tracks *B*, guided by rollers *C*. The bell-crank lever *D*, pivoted on the pin *E*, carries at the ends of its arms two rollers, one of which fits in a groove in the weight *A* and the other in a groove in the sleeve *F*. Thus, any radial movement of the weights causes a vertical movement of the sleeve, which is then, in turn, communicated to the fuel-pump mechanism through the external collar *G*. The entire governor mechanism operates in an oil bath, there are few pins or parts to wear and the regulation is excellent." "Now, chief," broke in Kelly, who thought he had trapped Egan, "you kicked about a governor with two springs, because they weren't exactly alike. Yet here you are boosting that same kind of a governor." J. R. laughed good naturedly and proceeded to explain.

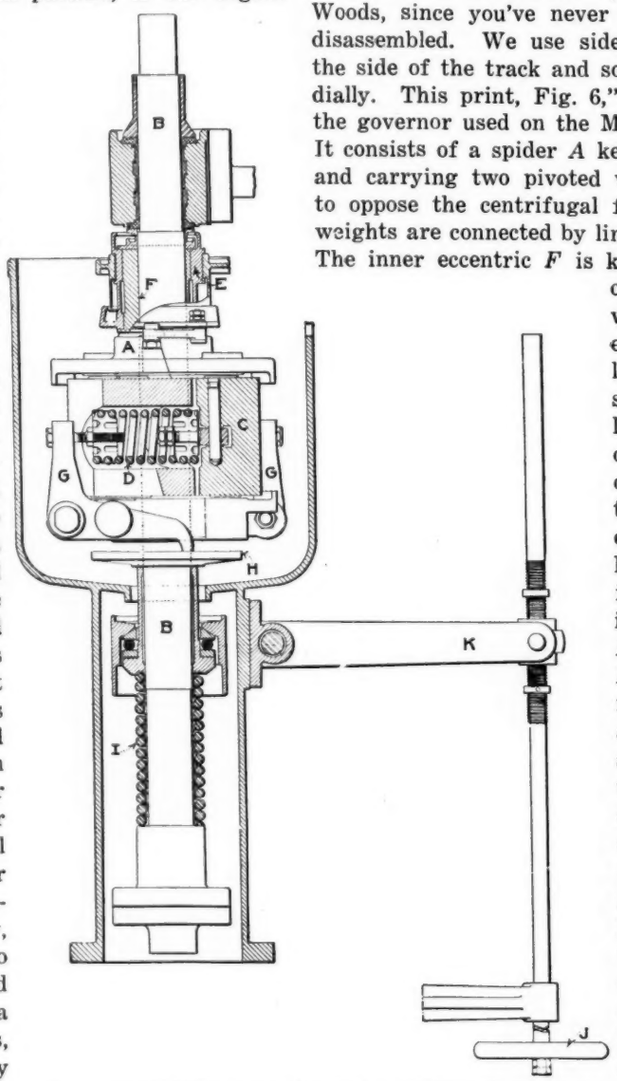


FIG. 6. GOVERNOR OF McINTOSH & SEYMOUR ENGINE

"If you'll remember, my remarks referred to a governor in which the weights are connected together and control the sleeve by a system of pivoted links, so that the two springs really act on both weights. In the Jahns governor each weight acts on its own spring, and as the linkage is not rigid there may be some slight difference between the springs without affecting the regulating qualities of the governor. The Jahns governor adapted for use on the Busch-Sulzer engine is shown in Fig. 5. In this case the sliding collar *A* is above the governor instead of below, to simplify the connection to the fuel pump. Ball bearings *B* on the sleeve prevent binding and eliminate friction, and as a result the governor is very sensitive. There is one point to be emphasized and it applies to all other governors—keep the governor parts scrupulously clean. Don't let grit accumulate, and the governor's life will be doubled."

"Chief," said Woods, seeing that Egan was through with this governor, "what keeps the two weights from jumping the track? When they revolve, I'd think they would hang back, and the rollers slide off the runway."

"That's a reasonable question for you to ask, Woods, since you've never seen our Jahns governors disassembled. We use side rollers that bear against the side of the track and so make the weights run radially. This print, Fig. 6," continued Egan, "outlines the governor used on the McIntosh & Seymour engine. It consists of a spider *A* keyed to the vertical shaft *B* and carrying two pivoted weights *C*, with springs *D* to oppose the centrifugal force of the weights. The weights are connected by links to the outer eccentric *E*. The inner eccentric *F* is keyed to the shaft, and the outer one moves around it when shifted by the governor. To secure speed regulation, the outer end of each spring is held by a regulator lever *G* whose other end rests on a flat collar *H*. The thrust of the levers is opposed by the spring *I*, and to make a change in the speed, the handwheel *J* is turned, moving the lever *K* and so changing the tension of the springs *D* by moving the flat collar *H*." "Why are the weights made so heavy?" Woods asked. "To overcome the resistance. Remember that the fuel-pump plunger is driven from the governor eccentric. If the plunger is $\frac{5}{8}$ in. in diameter and the injection air pressure is 1000 lb. per sq.in., the governor will have a resistance of about 350 lb. to overcome, and so the weights must be heavy. This feature doesn't seem to be objectionable, for the governor handles a variable load in fine shape. The weight of the flywheel has a lot to do with the closeness of regulation of a governor. The flywheel must be heavy enough to take care of any speed variation during a single cycle, for the governor cannot act between two successive power impulses. If the flywheel is too light, it will not be able to absorb the excess energy between explosion and the following compression, and if the governor attempts to control the fluctuations, hunting will result. If the flywheel is too heavy, and the load comes on suddenly, the inertia of the wheel will prevent a rapid change of speed and the decrease of

engine speed will be very slow. If there is much internal resistance, the governor will act slowly and allow the engine speed to die down considerably before the fuel charge is increased. At this point the inertia of the flywheel will be so great as to prevent the engine speed from returning at once to normal. So, you see, with a varying load a flywheel can be too heavy as well as too light. This is a matter for the designer rather than the operator, but poor calculation of flywheel weights has condemned more than one perfectly good engine." "Why is it that we've had so much trouble with the governor drive shaft?" Kelly wanted to know. "Well, let's look into it," said Egan. "Fig. 7 shows the governor drive shaft of a well-known engine, the weight of the governor and the shaft being carried by the ball-thrust bearing *A*. At the bottom the shaft is driven from the crankshaft through the helical gears *B* and *C*, and at the top the helical gear *D* drives a similar gear *E* on the camshaft. The pressure exerted between the teeth of the helical gears causes a downward thrust that is added to the weight of the governor and shaft. If the balls or the race of the bearing *A* wears, the shaft will be lowered by the amount of the wear, throwing the thrust on the teeth of the gears and causing rapid wear. It's true, as the manufacturer's representative said, that the ball bearing should be attended to; but it's incased and can't be seen in operation. It doesn't take but a few minutes, after a ball breaks or a ball race cuts, until the gears are screeching and cutting. This, Kelly, has been the big part of our trouble. The bronze bearing *F* at the base of the vertical shaft, gives some trouble by wearing. It merely acts as a guide for the shaft; but its oil supply easily chokes if it warms up, and the result is a ruined bearing. I would say that an extra bearing is a mighty good thing to keep around. It doesn't cost much and means only a short stop instead of a long wait to secure one from the builder." "Well, how about the upper bearing?" demanded Kelly. "The cause of wear at this point is due to the tendency of the two gears *D* and *E* to push apart. It happens that the vertical shaft bearing *G* is weaker than the opposing bearing on the camshaft, and so the upper bearing wears. If it wears the slightest amount, the gear has a tendency to climb, throwing still more pressure on the bearing. I think it wouldn't wear much if the oil grooves were properly made. At least, the last time we replaced this bearing, I cut the grooves only half way down the bore, and that seems to have stopped our trouble. Evidently, when the grooves extend the full length, the oil flows to the bottom of the bearing without forming a film around the shaft. By grooving the bearing only part way down the oil flows to the bottom and then spreads out, lubricating the entire bearing." "Mr. Egan, how can you overcome the trouble with the helical gears wearing? I've noticed you had Kelly filing the teeth." "Kelly's filing the teeth was only a temporary makeshift to smooth up the surfaces. The only hundred per cent. remedy is to replace the bronze gears with oil-treated steel gears." "How about the gears on a horizontal engine?" Kelly asked. "Do the same troubles show up?" "Before we ever put in a vertical engine, we had a 300-hp. horizontal engine. The gears troubled us more than anything else except the air compressor. I kept a record of thirty-one different high-compression engines by writing every three months to the engineers. From this dope it appears that trouble with the gears and layshaft in horizontal engines and with the vertical drive shaft in vertical engines is never entirely absent. Cleaning and regrinding needle valves is expected, but gear trouble is not natural and is uncalled for if the gears are designed properly. Now, boys, tomorrow we've got to overhaul the air compressor of the No. 2 engine, and that means a lot of hard work; so we'd better quit and go to bed."

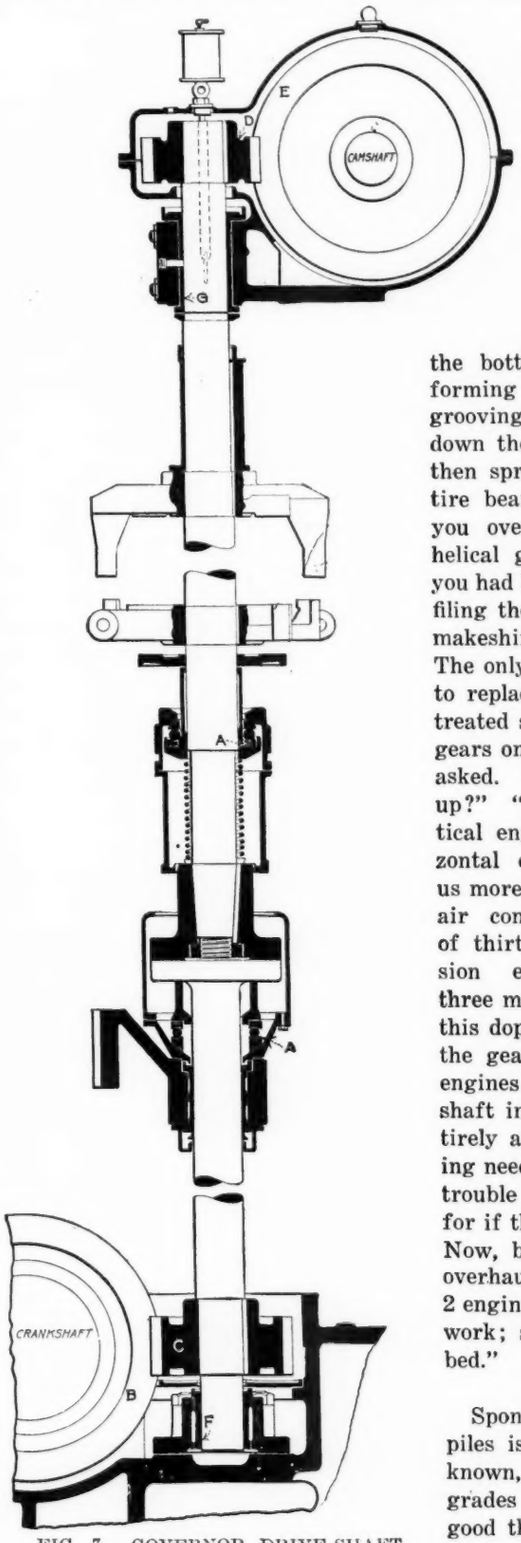


FIG. 7. GOVERNOR DRIVE-SHAFT ARRANGEMENT

Spontaneous combustion of coal in piles is common and it is, as is well known, likely to occur with the poorer grades of bituminous coal. It is a good thing to remember, in this connection, that coal should not be piled to a height greater than twelve feet, and that when spontaneous combustion does occur, water has but little effect in putting it out. To prevent coal piles from taking fire, the coal should be turned over when undue heating is apparent.

The Electrical Study Course—Inductance and Resistance on Three-Wire Generator

Presents the customary arrangement of the armature connections and the inductances used for a three-wire generator. Also deals with the direction of flow of current through the inductances for conditions of unbalanced load.

IN THE preceding lesson it was stated that both direct and alternating currents can flow through the same conductor at the same time, and that by making use of this fact and having the conductor in the form of an inductance, it is possible to restrict the flow of the alternating current to very small values, while permitting free passage to the flow of the direct current. We shall now investigate how such an arrangement applied to a three-wire generator will provide a three-wire system of distribution, and do it as economncally as would a balancer set in conjunction with a plain two-wire generator.

In the discussion leading up to the presence of alternating current in the inductances connected to opposite taps of the armature winding of the generator, the inductances were considered as revolving with the armature, as illustrated in Fig. 1, in which A represents the armature winding, a and b the brushes on the commutator for the direct current, and c and d the points at which the inductances L_1 and L_2 are connected to the armature winding. It was shown that with such an arrangement the voltage from a to g is the same as that from g to b, irrespective of what part of its revolution the armature is in. As a matter of fact, the inductances do not have to revolve with the armature and generally in practice they are made stationary, contact being made with the points c and d through slip rings and brushes, as illustrated in Fig. 2, in which SS represents the slip rings that revolve with the armature A. The inductance is usually made up in the form of laminated square iron loop with a coil wound on each of two parallel legs, as shown in Fig. 2. The neutral is connected at point g between the two coils. On account of the easy path offered to the flow of magnetism in the iron core, a very small alternating current flowing in windings L_1 and L_2 set up a mag-

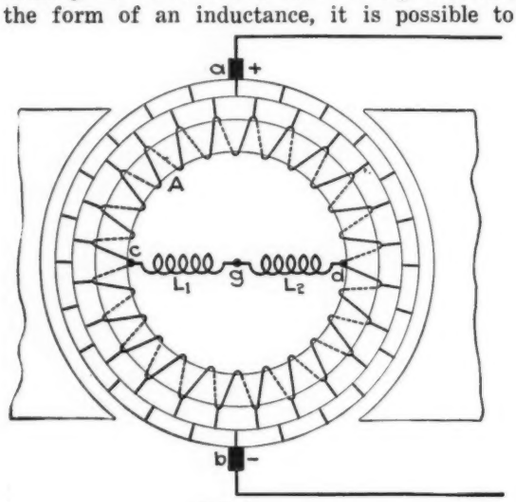


FIG. 1

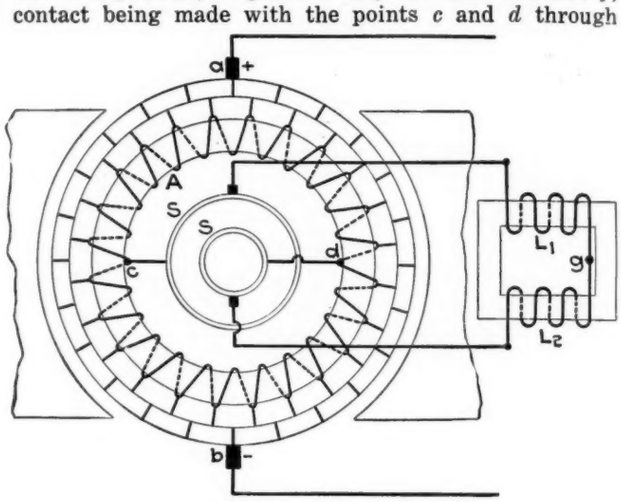


FIG. 2

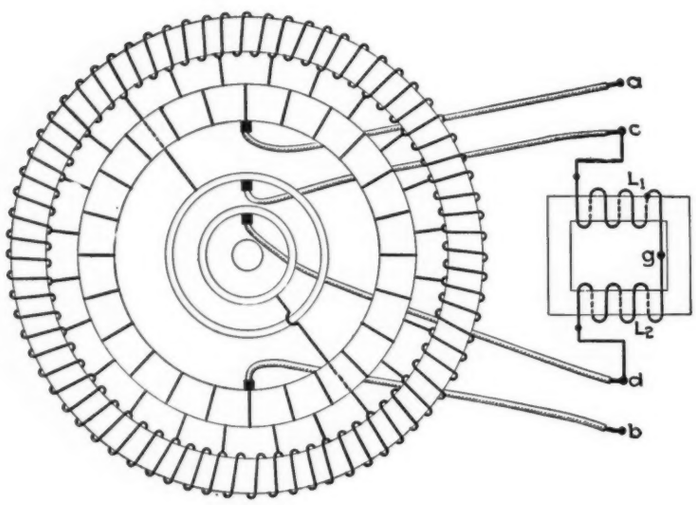


FIG. 3

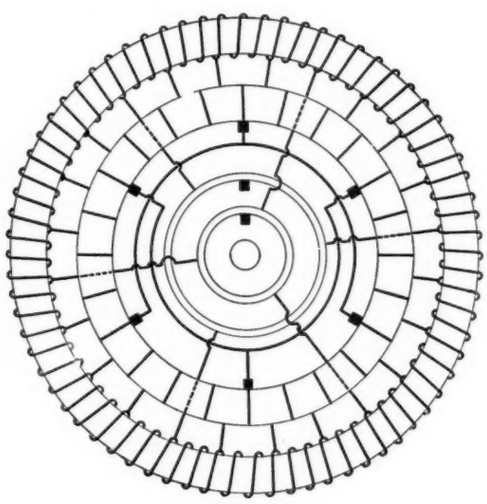


FIG. 4

FIGS. 1 TO 4. SCHEMATIC DIAGRAM OF THREE-WIRE GENERATORS

netic field sufficient to produce a counter-voltage in the coils almost equal to the alternating voltage applied to them, consequently keeping the current down to a very small value. Assume that the resistance of the two coils L_1 and L_2 in series is 0.2 ohm; if the coils were connected to 220 volts direct current, the amperes would equal $\frac{E}{R} = \frac{220}{0.2} = 1100$. On the other hand, when alternating current attempts to flow in the coils, owing to the changing value of the magnetic field there is a counter-voltage developed in the winding similar to the counter-voltage generated in the armature of a direct-current motor. Assume that the difference between the applied alternating voltage and the counter-voltage is one volt, which is not very far from what we might expect to find in practice; that is, the applied voltage is one volt higher than the counter-voltage This leaves only one volt effective to cause the current to flow through the resistance of the inductances, or the

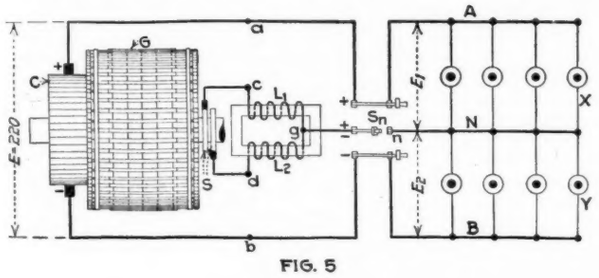


FIG. 5

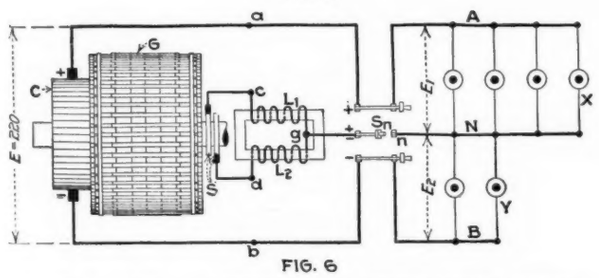


FIG. 6

FIGS. 5 AND 6. THREE-WIRE GENERATORS USING INDUCTANCE CONNECTED TO A LOAD

current in this case will equal $1 \div 0.2 = 5$ amperes. This 5 amperes may be considered as the current required to set up the magnetic field.

In Fig. 3 are shown the connections as they would actually exist in a ring armature, which has been chosen because of the simplicity of representation. In practice a drum-type armature is of course used, and there may be any number of pairs of poles, instead of only one as is the case for the armature shown. If more than one pair of poles are used, there would have to be as many taps to each slip ring as there are pairs of poles, and of course also as many direct-current brushes. In a six-pole machine, for example, the arrangement would be similar to that in Fig. 4.

The arrangement illustrated in Fig. 3 may be more simply shown as in Fig. 5, where G represents the armature, C the commutator and S the slip rings. These latter are connected to the inductances L_1 and L_2. The figure further represents the manner in which connections would be made to a three-wire service. As indicated, a and b are connected to the outside wires A and B, and the mid-point g of the inductances is connected to the neutral N. The functioning of such an arrangement will be made clear in what follows. If the load is exactly balanced as in Fig. 5, E_1 and E_2 will have the same value in this case, $\frac{1}{2} \times 220 = 110$ volts. Now it will be remembered that the voltage from a to g and from g to b is also half the voltage across ab and therefore likewise 110 volts. Consequently, the point n is at the same potential as the point g, and if switch S_n were to be closed no current would flow through it one way or the other.

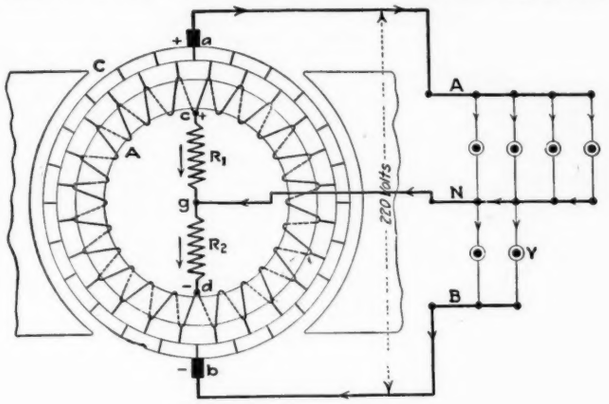


FIG. 7

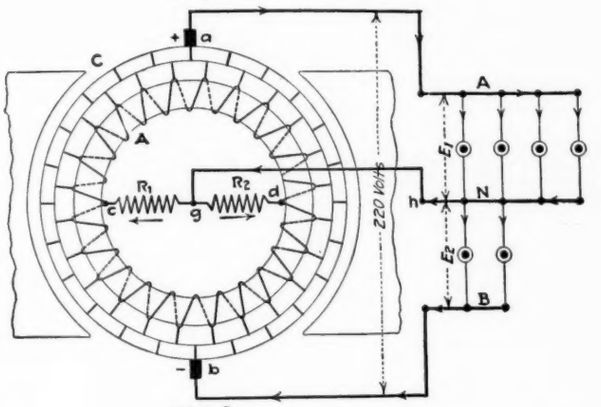


FIG. 8

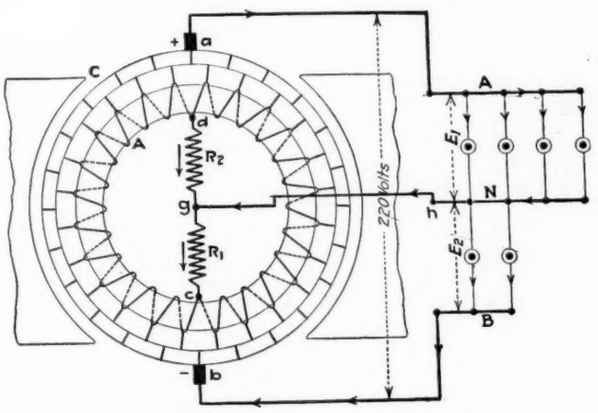


FIG. 9

FIGS. 7 TO 9. THREE-WIRE GENERATORS USING RESISTANCE CONNECTED TO A LOAD

Assume now, that the load is unbalanced as in Fig. 6, there being more lamps across AN than across NB. Then, as explained in the previous lessons, E_1 will be less than 110 volts and E_2 more. Since the largest part of the load is on the positive side of the system, the current would flow from n to g through L_1 and L_2 to the slip rings and back through the armature winding to the brush a, if the switch S_n were closed.

A fundamental difference between plain resistances and the inductances L_1 and L_2 is to be noted here.

Suppose the inductances to be replaced by resistances of 0.1 ohm each and their position of some particular instant to be that shown in Fig. 7. The current flowing through them, if there were no external load on the generator, would be equal to their combined resistance divided into the terminal voltage, or $\frac{220}{2 \times 0.1} = 1100$ amperes. Assume that load is placed on the system such that the resistance of X is 1.0 ohm and that of Y 1.25 ohms. Then the total resistance R_a across ag will

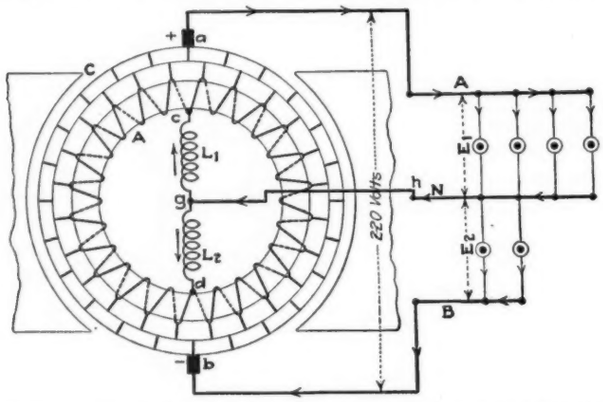


FIG. 10. THREE-WIRE GENERATOR SHOWING DIRECTION OF CURRENT IN THE INDUCTANCE

be the combined resistance of R_1 and R_x in multiple, where R_x represents the resistance of load X; hence $R_a = \frac{1}{\frac{1}{R_1} + \frac{1}{R_x}} = \frac{1}{\frac{1}{0.1} + \frac{1}{1.0}} = 0.09091$ ohm. Similarly, the resistance R_b across gb would be found from the relation $R_b = \frac{1}{\frac{1}{R_2} + \frac{1}{R_y}} = \frac{1}{\frac{1}{0.1} + \frac{1}{1.25}} = 0.09259$ ohm. The total resistance across ab is equal to $R_a + R_b = 0.09091 + 0.09259 = 0.1835$ ohm, and the total current delivered by the generator would be $\frac{220}{0.1835} = 1199$ amperes. The voltage E_1 across ag is equal to the resistance R_a times the total current, or $0.09091 \times 1199 = 109$ volts, and the voltage E_2 across gb would therefore be $220 - 109 = 111$ volts. The current taken by R_1 would equal its resistance divided into the voltage across ag, or $\frac{109}{0.1} = 1090$ amperes, making the current through X equal to $1199 - 1090$, or 109 amperes. Similarly, the current taken by R_2 would be $\frac{111}{0.1} = 1110$ amperes, and that through Y would be $1199 - 1110 = 89$ amperes. Now the difference between the current in X and Y is $109 - 89 = 20$ amperes, which flows through the neutral N and through R_2 to the armature winding in the direction of the arrowheads.

This increases the current through R_2, therefore the current through R_1 will have to decrease in proportion to the current increase through R_2, and we find this to be the case, since the former has a value of 1090 amperes and the latter 1110 amperes. The current through R_1 and R_2, it has been shown, would be 1100 amperes if there were no external load, hence under the conditions of load assumed, the current through R_1 has increased from 1100 to 1110 amperes, or 10 amperes. Thus, the decrease in one is equal to the increase in the other and each is half of the neutral current; namely, 20 amperes. This is the condition when the armature is in the position shown. When the armature has made one-quarter revolution, as in Fig. 8, the voltage across cd is zero; however, as explained in previous lessons, there is 110 volts from a to g and from g to b, consequently the neutral current will divide equally, 10 amperes flowing through R_1 and section ac of the armature and 10 amperes flowing through R_2 and section ad of the armature. When the armature has completed another quarter of a revolution, as in Fig. 9, R_1 is then carrying all the neutral current just as R_2 was in Fig. 7.

When the resistances are replaced by inductances, the same condition holds true except unless the unbalancing is very small, the neutral current divides equally between the inductances L_1 and L_2 at all parts of the revolution, and we will actually have a current flowing from g to c through L_1 and from g to d through L_2, as in Fig. 10; that is, one will flow up and the other down as indicated by the arrows, whereas in the case of the resistances of Fig. 7 the currents in R_1 and R_2 would have the same direction and would differ only in value. How the neutral current will divide and flow in opposite directions through the inductances will be made the subject of the next lesson.

The problem of the preceding lesson concerned a generator that supplies power to a two-wire system, the load on which consists of 500 fifty-watt 110-volt lamps, situated 200 ft. from the generator. It was required to find the capacity that the generator must have, the size conductor required for the line if rubber-covered wire is used, and the amount the generator must be overcompounded at full load to maintain constant voltage at the lamps. The total load is equal to the power required by each lamp times the number of lamps used, or, if W represent the load, we have $W = 50 \times 500 = 25{,}000$ watts. The current re-

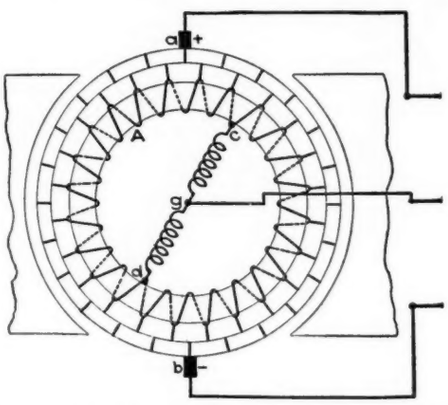


FIG. 11. DIAGRAM OF THREE-WIRE GENERATOR

quired to be delivered by the generator would be the number of watts in the load divided by the voltage, or $\frac{25{,}000}{110}$, which gives 227 amperes. Upon consulting the table of carrying capacities, we find that a No. 0000 wire would be required if rubber insulation is used. If the voltage at the lamps is to be the same at full load as at no load, it follows that the voltage at the generator must rise by the amount of the voltage drop in the line. The voltage drop in the line is equal to the current flowing in it times its resistance. The current is 227 amperes, as computed, and the resistance can be determined by looking up the resistance of No.

0000 wire per foot and multiplying by the length of wire in the line. Since the line is 200 ft. long and consists of two wires, the total length of wire is 2×200 ft., or 400 ft. From the table of resistances we find that No. 0000 wire has a resistance of 0.05023 ohm per thousand feet, making its resistance per foot $\frac{0.05023}{1000}$ or 0.00005023 ohm, and the resistance of the line $400 \times 0.00005023 = 0.02009$ ohm. From this we have that the voltage drop in the line is $227 \times 0.02009 = 4.56$ volts, which is the number of volts the generator must be overcompounded to maintain 110 volts at the lamps when they are all turned on.

In Fig. 11 the voltage across *ab* is 220 volts. At the instant represented, the voltage across *cd* is 190 volts. What is the voltage across *ac* and *db*? Is *c* positive or negative with reference to *d*? Is *c* positive or negative with reference to *a*? Is *d* positive or negative with reference to *b*? What is the voltage between *a* and *g*, and between *g* and *b*? Is *g* positive or negative with respect to *a* and *b*? Does the position of the armature have any effect upon the voltage relations of *a*, *g* and *b*?

Safety Platform at Coal Scales

A Middle-Western central station has embodied a safety feature in a new track-hopper house just constructed. This house stands over the double-track scales installed over the track hopper. It is large enough to accommodate two railroad cars standing side by side.

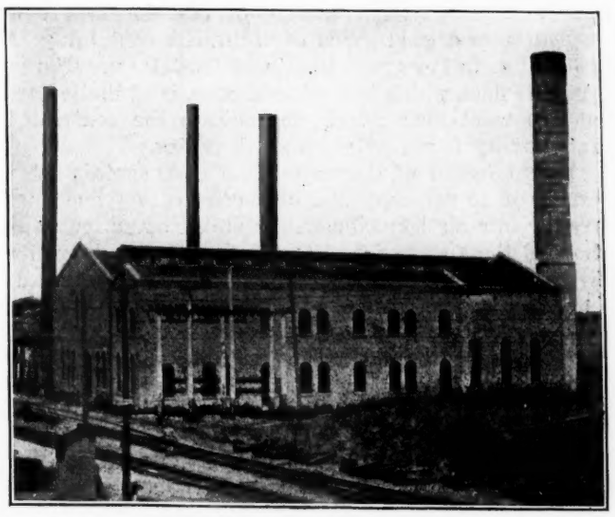
When coal is being dumped into the hoppers in such a house, it is the usual practice for men to stand on the edges of the cars to "bar down" the coal that may stick in the car. This trouble is especially bad in cold weather, when the coal may freeze in the cars. Men engaged in such labor are required to exercise considerable skill in balancing themselves on the edges of the cars lest they fall or be forced to jump to the ground or into the car. Accidents sometimes result from such falls. To relieve this condition the company has built a runway around the walls of the house and another over the tops of the cars at such a level that the men standing on this runway can bar down the coal without danger of falling. A railing around the runway further adds to the safety of this position.

How a Steel Stack Was Removed and Reinstalled

By Clifford A. Elliott*

The removal of a steel smoke-stack 7 ft. in diameter from the Vineyard power house of the Pacific Electric Ry. and its reinstallation at a new power plant situated at Torrance was decided upon as an economical measure. The boilers which this stack served at the Vineyard Station were no longer in service, and so the stack was not being used. It rested upon boilers 12 ft. high. Forty feet of the stack extended between the top of the boiler and the roof, and the remaining portion, 55 ft. in length, projected beyond the top of the roof.

Owing to limited building space, the removal of this stack intact was not possible as it could not be lowered through the roof of the power house and be removed through the doors or windows of the building. A contractor was found, however, who was willing to undertake its removal in two sections. This was the method finally adopted. A large steel beam which extended through the roof as a part of the construction of the Vineyard power house offered a most favorable and substantial support for the installation of a gin-pole and its rigging for handling the stack. A gin-pole was installed and the hoisting line was run down through an opening in the roof to the boiler room and outside the power house to a donkey engine. The section of the stack extending beyond the roof was first released and was lowered by the aid of the gin-pole to the roof. It was then moved over the surface of the roof on rollers for a distance of about 40 ft. to the building line. The gin-pole was then reset, and by its aid the stack



VINEYARD POWER HOUSE BEFORE STACK (THE LARGE STEEL ONE) WAS REMOVED

was lowered over the side walls of the building to the adjoining power-house grounds, a height of approximately 50 ft. The second section of the stack, 40 ft. long, extending between the top of the boilers and the roof, was then lifted and placed on the roof, from which it was lowered to the ground in the same manner as the upper section had been handled. The total expense of this removal and relocation of the stack will not exceed $600, says the *Electric Railway Journal*, and will show a substantial saving over the cost of a new stack at the present high market prices. The distance between the two power houses is twenty miles and the stack was transported with motor trucks. The Torrance power house, which is at present about 35 per cent. finished, will serve the new power repair shops of this company. The stack when reërected, will serve two 250-hp. boilers, which are also being transferred from the Vineyard power plant to the new power house.

*Cost Engineer Maintenance of Way Department, Pacific Electric Railway.

Wherever possible install thermostatic traps on larger heating coils and regulate the amount of heat desired in the coil by the supply valve. This, however, can be done only when the return is water-sealed or has a check valve or is drained to a vacuum return line. Best results are secured with radiators of the hot-water pattern, with the steam supply at the top of radiator and return at the bottom.

Burning Coals of the Southwest

By W. M. PARK.
Construction Engineer, Green Engineering Co., East Chicago, Ind.

Characteristics of the wide variety of coals found in this region. The need of large furnace volumes, liberal grate area and unusual quantities of refractory material in the ignition arch and bridge-wall.

PRODUCTION of coal in the Southwest fields of the United States has not kept pace with that of Eastern fields, owing to the smaller demand on account of the extensive oil developments of that section, the lesser density of population and fewer manufacturing enterprises. The quality of coal in this region varies from a good grade of anthracite containing 14,000 B.t.u. to low-grade lignite of 6000 B.t.u. The anthracite field, which is in New Mexico, is of limited area and is mentioned merely to indicate the contrast in fuel quality found within a small radius.

In the Southwest the majority of coals contain ash in excess of 15 per cent. and of a composition that fuses readily into a sticky clinker. In stoker operation agitation of the fuel bed and the slicing required in hand firing aggravate clinker formation and make continual operation prohibitive except at low combustion rates.

During the last eight years progress has been made in the design of furnaces that will handle these coals successfully, so that engineers now have the same assurance of ultimately satisfactory results that is felt when designing furnaces for Eastern coals. In the following reference is made to a few modern settings from which creditable performances have been secured.

Fig. 1 shows a horizontal-pass boiler equipped with a chain grate having a ratio of grate area to steam-making surface of 1 to 52. This furnace readily ignites

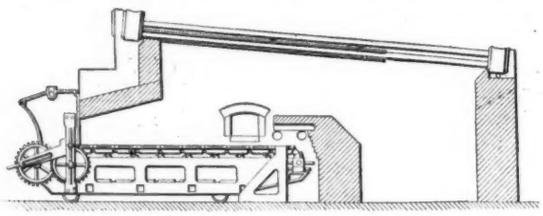


FIG. 1. CHAIN GRATE SERVING HORIZONTALLY BAFFLED BOILER

and burns 40 lb. of coal hourly per square foot of grate and under test conditions has given 72 per cent. efficiency when burning a New Mexico coal of the following analysis:

Moisture, per cent	17
Volatile, per cent	33
Fixed carbon, per cent	33
Ash, per cent	17
B.t.u., commercial basis	8,500

The higher-grade coals of New Mexico are used quite extensively in El Paso, Tex., on a number of chain-grate installations. These coals are all rich in volatile, and some appear to contain, either in the volatile matter or in the lighter particles of ash, some element that attacks even the best grades of firebrick, if the furnaces are designed to give high gas velocities.

A furnace for a vertically baffled boiler is shown in Fig. 2. The outstanding feature of the design is the ample combustion chamber provided by headroom of 11.5 ft. under the bottom of the front header. The high-set sloping arch in connection with a vertical bridge-wall gives intense reflection and radiation of heat on the entering fuel, and a large opening between the arch and the bridge-wall insures nominal gas velocity. This type of furnace has given highly satisfactory performance, operating continuously at averages of 15 per cent.

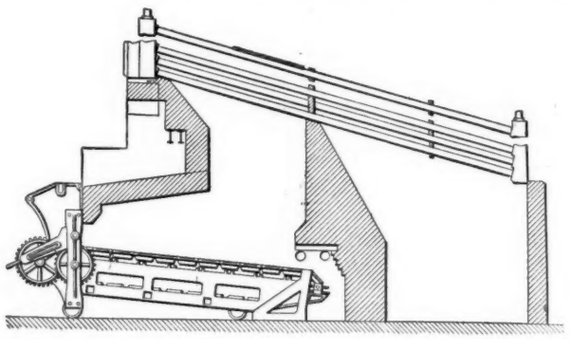


FIG. 2. AMPLE COMBUSTION CHAMBER, HIGH STEEP ARCH, LARGE GAS OUTLET

CO_2 and 2 to 3 per cent. ashpit loss when burning northeastern and north-central New Mexico coals with the following representative analysis:

Moisture, per cent	2.87
Volatile, per cent	34.27
Fixed carbon, per cent	46.08
Ash, per cent	16.78
B.t.u., commercial basis	12,023

About sixty miles west of Ft. Worth, Tex., is an isolated bituminous coal field of small area. The screened-lump grades of this coal have a heat value of 12,500 B.t.u. A large percentage of the output is used by the Texas & Pacific Ry., leaving a limited amount for domestic consumption in a territory traversed by this railroad. The screenings are burned on chain-grate stokers at several of the mine plants and at a large public-service plant in Ft. Worth. The better grades of screenings have a heating value of 10,500 B.t.u. while the lower grades run as low as 8300 B.t.u. and have a proximate analysis of:

Moisture, per cent	3.50
Volatile, per cent	30.70
Fixed carbon, per cent	26.24
Ash, per cent	39.56

To burn this coal successfully it is necessary to cover approximately 90 per cent. of the furnace with an arch set with a steep slope and ample height, which in combination with a vertical bridge-wall gives intense reflection of heat upon the fuel bed at the entrance to the furnace. This furnace is shown in Fig. 3. Naturally, it is necessary to provide unusually large grate area to burn sufficient quantities of this low-grade fuel. Some of the stokers at the mines have a ratio of grate area to steam-making surface as low as 1 to 25.

In the western counties of Arkansas there is mined a grade of coal known as semi-anthracite, having the following average analysis:

Moisture, per cent	3.5
Volatile, per cent	14.0
Fixed carbon, per cent	60.5
Ash, per cent	22.0
B.t.u., commercial basis	11,400

The glossy appearance of freshly broken pieces and the nature of the fracture is similar to that of Pocahontas coal. The percentages of volatile matter and moisture also approximate those of the latter fuel, but the different nature of the volatile and the considerably higher percentage of ash give the coal characteristics in burning that are quite different. When heated, the tars appear to volatilize before they reach the temperature at which they would become plastic as contrasted with Eastern coking coal. Instead of caking together in lumps, the smaller chunks disintegrate under heat so that the fuel bed is like a mass of loose sand. Because the coal has these characteristics, it produces a dense fuel bed, and therefore the depth of fire must be less than that used with high-volatile coals for corresponding drafts and combustion rates.

These low-volatile coals are perhaps the most difficult fuels to burn of any encountered in this district, on account of the difficulties of ignition. Even with the furnaces designed for the most intense concentration of heat at the ignition point, semi-anthracite coals will ignite only on the surface if radiant and reflected heat alone are depended upon. The ignition of fuel in the lower part of the fuel bed can be accelerated by the use of a special grate having corrugated face tile in contact with the fuel.

Fig. 4 shows an experimental design of furnace first worked out for semi-anthracite coal. It involves an expensive lot of special tile shapes, and the maintenance of the brickwork is high. Equally good results may be expected with the simpler type of arch shown in Fig. 2, though for the boiler and for the length of stoker shown in Fig. 4 the furnace projection and length of arch should be increased when the reversed arch is eliminated.

From a long series of tests of from eight to twenty-four hours' duration, six tests are presented in the accompanying table. Efficiencies as high as 78.5 per cent. were obtained where unusual pains were taken to maintain steady conditions, but the list chosen does not include the maximum efficiencies. Tests typical of results readily obtainable are of greater value to the engineer, and this point was borne in mind in making the selection.

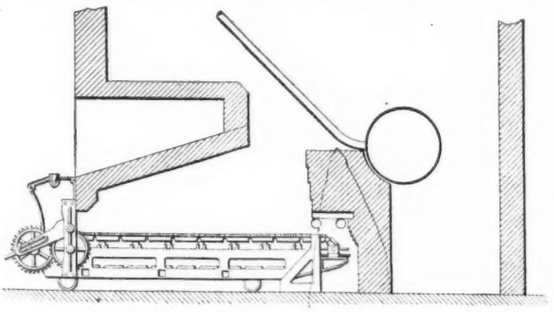


FIG. 3. HIGH STEEP ARCH COVERING ABOUT 90 PER CENT. OF FURNACE WITH VERTICAL BRIDGE-WALL CAUSES INTENSE HEAT REFLECTION

The writer's experience in burning the Southwestern coals leads to the following conclusions:

On account of the high ash content and the fusible nature of the ash, these coals can be burned with highest efficiency and least labor on a chain grate.

Most of the coals are of high volatile content, ignite readily and burn freely if provided with long, high-set arches.

Semi-anthracite ignites least readily, but if load conditions permit maintenance of steady furnace conditions, this fuel can be burned with high efficiency. With liberal grate area substantial overloads are possible.

As semi-anthracite crumbles in the fire rather than caking together, it is desirable to reduce the sifting of fuel and resulting holes in the fire by use of a stoker chain having finely divided and ample air space.

To secure high furnace efficiency at high rating, a large furnace volume is desirable. This is insured by setting horizontal water-tube boilers at a front-header height of 8 to 10 ft. if horizontally baffled, and 10 to 13 ft. if vertically baffled, above the floor.

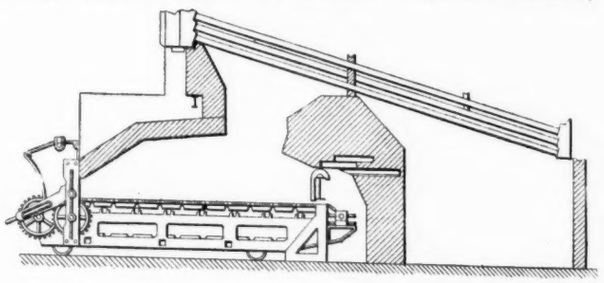


FIG. 4. EXPERIMENTAL FURNACE SUCCESSFUL IN BURNING SEMI-ANTHRACITE COAL

Provision should be made for furnace draft of 0.30 to 0.60 in. over the fire, and liberal grate area should be furnished to insure good overload capacity when burning the medium and lower grades of these coals.

RESULTS OF TESTS ON COALS OF THE SOUTHWEST

	Name of Coal					
	Jenny Lind, Ark.	Gallup, New Mex.	Raton, New Mex.	Strawn, Tex.	Dewar, Okla.	Huntington, Ark.
Moisture	4.25	19.55	2.45	2.81	6.27	3.88
Volatile	14.28	69.53	34.99	35.41	27.93	16.93
Fixed carbon	58.89	.....	46.08	40.23	46.37	56.06
Ash	22.58	10.92	16.48	21.55	19.43	23.13
B.t.u. per lb. as fired	10,874	8,367	12,059	11,200	10,706	10,912
Per cent. comb. in refuse	22.9	.....	15.9	22.3	26.9	19.8
Furnace draft, in.	0.27	0.27	0.12	0.11	0.23	0.38
Flue gas temp., deg. F.	463	584	507	477	520	444
CO_2 at furnace	13.5	15.5	15.6	12.2	12.6	12.4
CO_2 at uptake	12.9	10.0	11.7	9.7	10.0	11.6
Coal burned hourly per sq.ft., lb.	32.1	40.2	26.6	24.65	27.5	28.5
Per cent. builder's rating developed	170	146	154	134	139	148
Combined efficiency	74.1	71.8	72.8	73.6	71.7	72.2

Exports of crude oil and petroleum products from the Tampico district to the United States during 1918 amounted to 39,618,121 barrels.

The Clinker Grinder

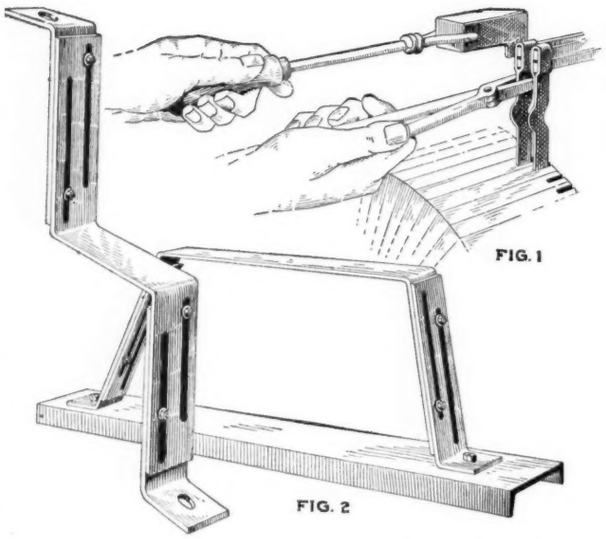
Burning coal containing 12 per cent. ash and evaporating 6.9 lb. of water per hour from and at 212 deg. F. per sq.ft. of heating surface, a 15,000-sq.ft. boiler will accumulate in its furnace more than 5.5 tons of ash per hour. For Western coals more than half this will be clinker. Large plants with careful, competent labor are getting away from handling the clinker and ash by hand and are breaking and discharging it by machinery. Next week's "Power" will have an article treating of the development, design, operation and performance of modern clinker grinders.

Rebuilding a Commutator under Difficulties

By H. WILSON

IT IS not always feasible to use orthodox methods when confronted with a hurried repair job in an awkward corner. One has just to devise the best means to suit the situation no matter what rules and regulations are broken.

The main ventilating unit of a large department store broke down during a period of very hot weather. This large fan was direct-driven by a slow-speed direct-current motor. On investigating it was found by a magneto test that the armature was grounded, and on making a drop test with a millivoltmeter the trouble was located on about six bars of the commutator. There was no sign of the trouble on the surface of the commutator, so it was evident that it would have to be taken apart and possibly reinsulated.



FIGS. 1 AND 2. METHOD OF UNSOLDERING ARMATURE LEADS, AND A TOOL REST FOR TRUING UP COMMUTATOR

At first it was thought that the work should be given to some outside firm, as it seemed impossible to do it with the limited means at our disposal; but after due consideration it was decided to undertake the job.

A chain block was put up overhead and the top half of the motor-field frame lifted off. The front bearing pedestal was then removed temporarily, in order to get the brush rigging off. The armature was bar-wound, the risers from the commutator bars being very close together. In order to unsolder them quickly, two irons were made of a special shape to suit the job, and a gas stove was connected alongside. When sufficiently heated, the risers were pulled clear of the winding with a pair of long-nosed pliers, as in Fig. 1. A strong band clamp was placed around the bars, and after removing the end ring the commutator was carefully taken off the boss, the bearing pedestal having been removed again for this purpose. The back bearing cap was loosened up and the armature allowed to rest on the bottom polepieces. On examination it was found that a section of the commutator had grounded onto the back ring and also that several bars had fused together underneath. The inside was quite moist, and the cast-iron boss was also in the same condition. Before taking the commutator apart, a larger piece of wood was turned to fit snugly inside of it. This allowed the bars to be drawn up true when building the commutator up again, without the aid of expensive clamping rings. All the micas were taken out and dried and the edges scraped, defective ones being discarded and new ones cut. The damaged part of the V-ring insulation was replaced with new mica. The bottom edges of all the bars were slightly beveled by means of a smooth file, and all excess solder was removed from the riser lugs with a gasoline torch. The commutator was then put together on a flat table, the bars being placed, with the risers down, and all around the wooden block previously prepared, then drawn up tight with the clamping band under which was placed a strip of fiber insulating paper.

After testing for short-circuits, the commutator was ready to be put back. The ends of the armature leads were cleaned and straightened out and all pieces of solder carefully picked out of the windings. After the commutator was replaced, it was heated to loosen up the shellac on the end V-rings, and the bolts were pulled up tight. The conductors were then soldered into the risers. The next operation was to true up the surface of the commutator.

A portable slide-rest outfit with an adjustable-stand arrangement, Fig. 2, was available for this purpose. It had been designed to fit all the engine-driven generators in the plant. This was easily rigged up, but the next problem was, how to drive the machine.

After being unable to find a motor that could be used to drive the armature at a suitable speed, the idea was hit upon that the armature being heavy and easily kept moving, once started, might be run by foot-power. A pair of rubber-soled shoes was secured for one of the boys around the plant and the armature was revolved as indicated in Fig. 3. I don't know whether the boy had had any previous experience on the treadmill or not, but he made a good show at it. Once the armature was started revolving, by holding on to the chain block and running on top, it was found possible to take a fine cut off the commutator. This method was a bit slow of course, as the "engine" gave out occasionally, but it accomplished the purpose and it is doubtful if any simpler form of drive could have been devised for revolving an armature in its own bearings.

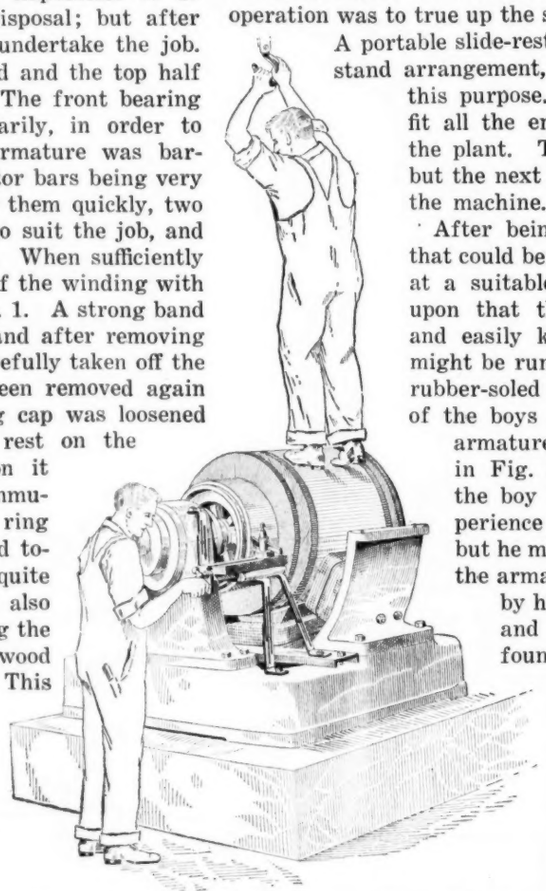


FIG. 3. METHOD OF TURNING ARMATURE TO TRUE UP COMMUTATOR

EDITORIALS

Conservative Claims of Interconnection Benefit

TYING together of steam plants to take mutual advantage of local differences in load conditions and capacity available at various periods is becoming more and more popular in the field of power supply. It is the duty of the industrial-plant engineer to "sit in" at any conference considering the making of a contract for interchange or for off-peak purchase of energy, and in such cases a thorough knowledge of the probable effect of different operating plans, based if possible upon experience, is decidedly worth while.

There is sometimes a temptation to exaggerate the savings secured by the purchaser of energy and to minimize the benefits conferred by such an arrangement upon the plant that sells the larger portion of the power involved. The industrial-plant engineer should not overlook the benefit his load may create with respect to the load factor of the system or station from which it is suggested that he take off-peak or other surplus energy. He must also recognize the fact that as soon as his own plant output is reduced through the substitution of purchased power, the tendency will be for the local station efficiency to fall unless the units are handled with great care. This increase in efficiency, which a desirable load may bring to pass in the case of the outside supplying organization, is an asset of no mean value.

In a representative instance of energy interchange the coal consumption of the larger plant was reduced from 2.08 pounds per kilowatt-hour to 1.85 pounds in a single year in which the plant output increased from twenty-two million to thirty-three million kilowatt-hours. A neighboring station increased its energy purchases from this station during this period from three million to fourteen million kilowatt-hours. This additional load was most welcome to the larger plant, a tidewater installation of seventeen thousand kilowatts rating. The smaller plant, rated at 4150 kilowatts, encountered a loss in efficiency during the year expressed in the rise of its coal consumption from 3.08 to 3.54 pounds, its own output falling in this period from twelve million to five million units. The interconnection enabled about four million more kilowatt-hours to be turned out by the two plants for practically the same combined coal consumption. There was therefore a net gain through the arrangement, but there was no ground in the case in point to claim that the big plant was doing everything for the smaller station and should therefore have the lion's share of profit in the contract arrangements. The cost of coal rose during the year from about five dollars to eight dollars and fifty cents per ton. The cost of production per kilowatt-hour actually turned out in the smaller plant during the year increased about one cent.

These figures indicate that it is not all "velvet" for a smaller station to purchase energy of a larger one; in other words, the profits of an interconnection carefully worked out and operated with engineering skill may be real and realizable, but may not be as large as the outside plant representatives would perhaps be tempted to assume. It is fair to recognize the *quid pro quo* of such situations. Here, and in numerous other instances, the larger station not only secures a better load factor and corresponding increase in operating efficiency, but enjoys the advantages of being connected with a source of reserve power that can be utilized on short notice. This means that the larger station need not expend as much money on extensions at a time when the first cost of plant equipment is at the upper levels reared by the demands of war service. On the other hand, the interconnection means that the smaller plant can take on a larger connected load and handle bigger peaks without making an investment in additional units of generating capacity. These considerations point the way toward a thorough analysis of production efficiency from various angles before the papers are finally signed. There are a good many different "slants" to this business of interplant contracts, and the engineer who fits himself to take part in such investigations and to bargain in a businesslike manner for his superiors' interests does well indeed.

Find and Fix the Cause

IT IS not always easy in the course of the day's work, when one is busy with a myriad of things that must be done and with fixing up after things that *have* happened, to find the time and the mental freedom to run in imagination through the things that *may* happen in the plant, and head them off. And yet how many a great catastrophe might have been averted by timely attention to some very little thing! Thorough, systematic inspection will go a long way if one does not fall into a habit of regarding it as routine and get too perfunctory about it. An indication too subtle to make its impression upon any other than a trained, interested and intent observer may, if its cause and meaning be ferreted out, reveal a serious waste or an imminent breakdown.

When something persists in going wrong, one should not be contented with fixing it up for the time being, but should seek it out to a finality and see what is causing the trouble. A joint that leaks persistently may mean an excessive stress in the piping, a leaky boiler rivet may mean an incipient seam crack, a bearing that persistently heats may mean dangerous deflection, a flywheel bolt that continually loosens or breaks points to a condition that should be corrected before something more serious happens.

A case in point occurred recently. The small bolt that held the latch block of a Corliss engine was continually stretching and breaking. In this case the trouble was in the bolt itself or the manner of its attachment, but instead of putting in a bolt of the proper size and material, correctly shouldered and fitted and held firmly in place with a castellated nut secured with a cotter pin or other fastening, the engineer was

content to keep a supply of spares and replace the faulty bolts as they broke. One day the bolt just stretched or worked out enough to allow the latch block to cock up so that the hook engaged it but could not let go, with the consequence that the engine took steam for the full stroke on that end in spite of anything that the governor could do and ran away, scattering its flywheel about the premises.

A thorough investigation of the cause of the recurrent trouble and the removal of that cause would have saved a lot of trouble and money. The engineer might not have got a large meed of credit for the job. It is usually not the things that he prevents from happening, but the things that do happen, that are known and credited to him. But he would not be worrying over another accident.

Stinginess Shackles Prosperity

EXCUSES for failure to purchase Liberty Bonds are the easiest things in the world to make and the hardest to justify. Many a reason that sounds plausible to the bond solicitor and that might possibly pass the scrutiny of a critical public is thrown out of court before the bar of conscience, the keenest and fairest judge in the world.

A lot of people fool themselves into believing that they cannot afford to invest in bonds. The bald truth is that they cannot afford not to. Particularly is this true of the Victory Loan, because it is so closely bound up with the industrial prosperity of the nation.

Observe what would happen if the people of America should ignore the coming appeal and should insist on letting the banks respond to it. The banks could probably absorb the full amount of the loan, but they would have little money left to lend to business enterprises, and the interest rates on that little remainder would be exorbitant.

The immense industrial system of the country is built on credit. Shortage of available funds in the banks to meet the needs of business would mean restriction of credit. Thus, industrial organizations of all kinds would be prevented from taking advantage of opportunities for legitimate expansion or for ventures into new and promising fields. The natural consequences would be decrease of industrial activity, increase of unemployment, hard times and widespread unrest. In other words, popular deafness to this appeal would be a boomerang that would knock the props out from under the platform of prosperity.

This is no fancy drawn from a troubled dream. It is a hard-headed fact taken from the book of experience. Volumes of optimistic talk and columns of cheerful interviews will not furnish the financial backing needed to push business. But the savings of millions of Americans from the earnings of the next few months, invested in Victory Notes and thus turned back into the channels of business, will sidetrack much of the trouble that is now approaching. Discontent does not flourish among workers that are busily engaged in useful and gainful occupations.

Prosperity is a condition of business—not a state of mind. Therefore, the way to improve it is to get behind it financially instead of rhetorically.

In plain language, boost the Victory Loan with hard cash as well as oratory. By so doing you will help yourself as much as you will contribute to the aid of the Government.

Photographing Injuries

IT HAS been common practice for engineering construction companies and others to keep on file photographs showing the progress made in the construction of the plant that is being built. These photographs, which are marked with the dates on which they were taken, form pictorial evidence of the progress of the development from the beginning to the finishing of the work.

Photographic evidence is accepted by the courts and many cases have been decided by it. This form of evidence might be employed to advantage by both the employer and the employee in cases of accident. Such evidence could be used by the one party to show the extent of the injury and by the other party to show whether an injury had been or had not been received. Of course this would not be possible in cases of internal injury, but burns and external cuts and bruises could be clearly shown.

If photographs were taken of all accidents and injuries there would be less chance for controversy as to the character of the injury in cases where the two interested parties could not get together, or adjust a satisfactory settlement. It would also seem that there would be less chance for fraudulent claims on the part of the one and the successful evasion and unjust settlement on the part of the other if this were done.

Our attention was recently called to a system of piping in which hot salt water was circulated, and although this piping was lead-lined, it deteriorated rapidly and in this particular case did not seem to give any better satisfaction than ordinary pipe. It is well known that hot salt water has a very deteriorating effect upon piping, but why it should attack lead-lined piping is somewhat puzzling. Perhaps some of our readers have had experiences that others would be glad to know about.

Judging from the numerous letters that have been published lately regarding the flooding of radiators in low-pressure steam-heating systems, it would seem that designing engineers of such installations have something to learn regarding such matters, or that they are willfully neglectful in putting in a system that will give satisfactory service.

One reason why piston-rod packing burns out is because it is not properly placed in the stuffing-box. Almost anyone can jam a lot of packing around a piston rod, but the man who knows how to do it properly will save the firm money in the cost of packing and himself a lot of trouble.

The chap who continues to write and speak of anthracite coal would probably be moved to uproarious laughter if he heard someone else mention hydraulic water or igneous fire.

A "Safety First" sign fell from a post and knocked a workman unconscious. He now is probably convinced that there is something in the popular slogan.

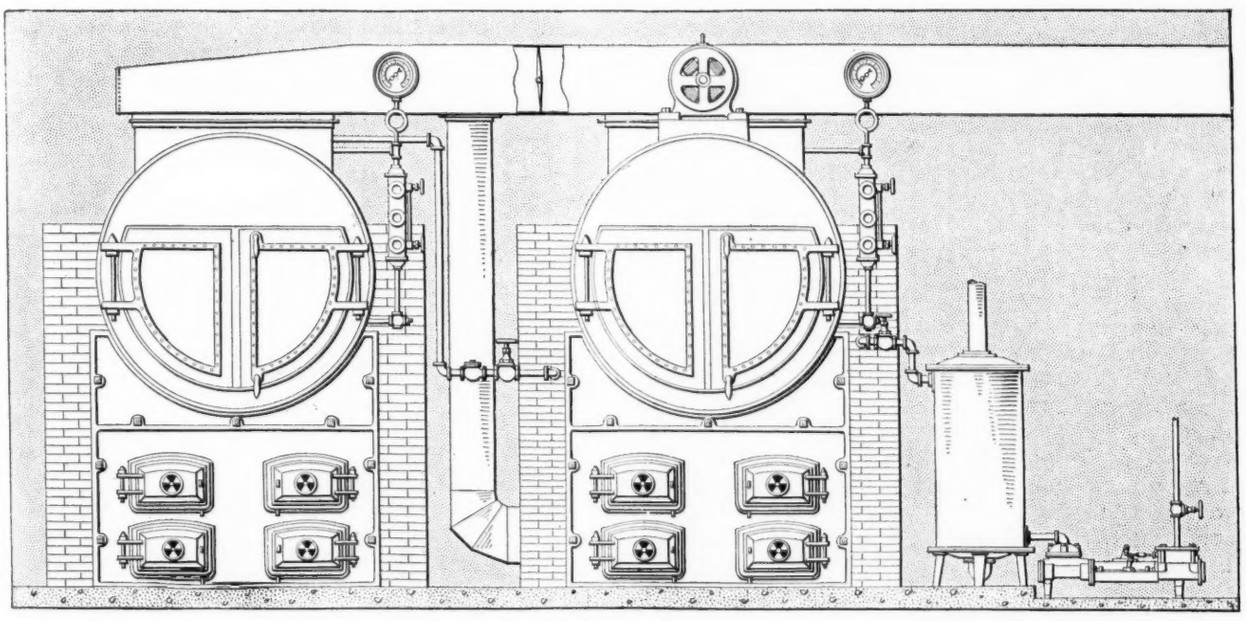
With the wide-awake fireman, excess air is just about as popular as an attack of influenza.

Correspondence

Using a Spare Boiler as an Economizer

In steam plants operating without economizers but having a spare boiler, considerable economy can be obtained and additional capacity gained by the use of the spare boiler as an economizer. In most plants very little expense would be incurred to put this plan into operation. The gases of combustion would be bypassed from the breechings of the live boiler or boilers, through a duct leading under the ashpit of the spare boiler. A greater draft would be required to draw the gases through the duct and the extra boiler setting, but the same is true of any economizer. This draft could be easily supplied by a suitable fan driven by an engine or a variable-speed motor in case the natural or stack draft was not sufficient.

The piping connections would be arranged to feed all the water into the "economizer-boiler," which should be subjected to steam pressure from the other units, maintaining a slightly higher water level in the "economizer-boiler" so that it would flow by gravity to the boilers being fired. This method would be preferable to carrying the boiler full of water, as injury to safety valves might result from this practice. In case more than one boiler was being fired, the feed water would be controlled by a valve for each one, but with only one boiler being fired the feed would be controlled at the pump and the water level in the economizer would be only slightly higher than that in the boiler.



SHOWING HOW A SPARE BOILER MIGHT BE USED AS AN ECONOMIZER

This plan offers a means of utilizing otherwise idle equipment and increasing the plant efficiency to a high degree, and it does not conflict with insurance regulations.

ALLARD C. FRENCH.

San Angelo, Tex.

Advocates Standardizing Pipe Unions

The fact that the various makes of pipe unions differ slightly, preventing the parts of one being used with the parts of another, leads to unnecessary waste, especially when tearing down pipe lines. For instance, injectors, etc., naturally come apart at the unions, and few workmen take the trouble to remove the disconnected pieces of unions from the pipes and connect them for use again, therefore many ejectors, injectors and ordinary pipe unions are thrown into the scrap as a result.

Why would it not be a good idea for manufacturers of pipe unions to agree on a standard for dimensions? There should also be standards for ground-joint unions. For instance, because of the cracking of a nut on a radiator-valve union probably not worth over 25 cents, I was obliged to buy a new valve costing $2, and further-more to go to considerable trouble to unscrew part of the union out of the radiator and get the valve off the pipe. That was a waste of material and of effort.

Is there any more reason for each manufacturer having his own particular standard dimensions of unions than there is for each having his own standard pipe threads?

I will venture to say that if such a standard for unions were adopted, no customer would be greatly inconvenienced even temporarily; and the eventual saving would be considerable to many thousands of users.

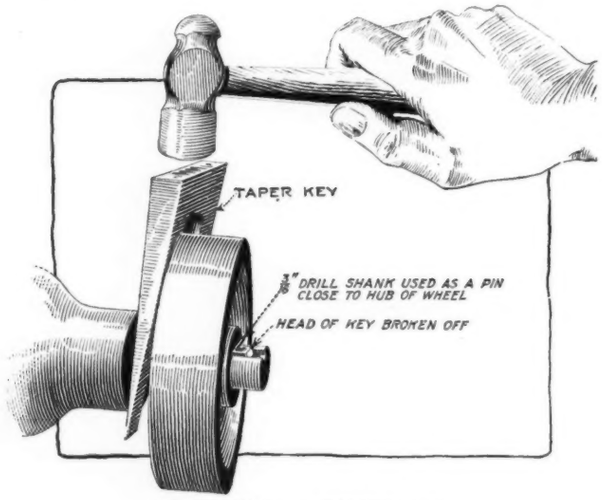
I would like it if the American Society of Mechanical Engineers would appoint a committee for the purpose of adopting a standard that manufacturers would agree to use.

F. D. BUFFUM.

Pittsburgh, Penn.

Removing Key from Motor Shaft

The illustration shows a kink that may be used when removing a pulley fitted with a taper key on which there is no head. The pulley is driven on the shaft as far as possible, and then a small hole (say $\frac{3}{16}$-in.) is drilled with a breast drill in the end of the key close to the hub of the pulley. A piece of round steel is put in



REMOVING A BROKEN KEY

the hole and the pulley is forced off with the split wedge as shown. All that is required of the pin in the drilled hole is to overcome the friction between the key and the shaft, which is not great if the pulley is not again driven onto the taper.

Lima, Ohio. B. C. MALICK.

What Are They Waiting For?

The present observed reluctance to spend money for power-plant equipment is so marked and so obviously wasteful that I am impelled to comment thereon. Buyers have frequently said that they are waiting for lower prices; and it is this attitude that is bringing the country to the verge of panic conditions. I can fully understand and appreciate the reason for this attitude with certain types of investment, but when it comes to such devices as mechanical stokers, the argument no longer holds.

Compared with hand-firing, the stoker will save from 15 to 20 per cent. of the coal. Seldom does the average efficiency of a hand-fired boiler exceed 55 per cent.; and more often than otherwise does the average of stoker firing exceed 65 per cent. As a matter of fact, hand-fired over-all boiler-room efficiencies are nearer 45 than 55 per cent. An increase of 10 per cent. in efficiency would mean an increase of 15 or 20 per cent.. as compared to previous operation; and this is what counts.

With coal at $3 per ton, a stoker operating at normal rating will at $10 per rated horsepower installed, give a return of 66 per cent. In the face of this fact someone must get busy to justify the waiting attitude. At the end of a few months the watchful waiter would have to get his stokers for nothing if he did not want to lose money. Every day he waits adds to his loss; and no possible reduction in price will begin to offset the loss due to his ever-present combustion inefficiency. Delay under such circumstances is economically unjustifiable.

Chicago, Ill. JOSEPH HARRINGTON.

Lamp Kept the Meter Warm

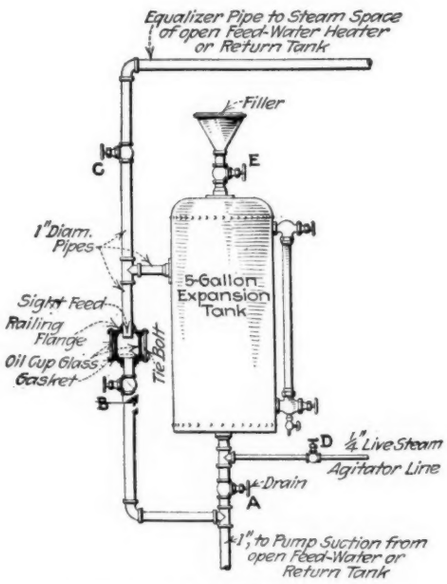
After having considerable trouble in getting a clock in a graphic meter to run, and noticing that it ran better on warm days than on cooler ones, a small carbon-filament lamp was placed in the meter and connected to a 110-volt circuit. After the lamp had raised the temperature in the meter case, the clock ran all right. It was decided that the oil became thick when cold and retarded the action of the clock movement. When the lamp warmed the inside of the meter, the oil thinned and the clock ran as it was intended.

Norristown, Penn. WILLIAM H. WATSON.

Home-Made Compound Feeder

The sketch shows a boiler-compound feeder that was developed by the supervising engineer of a concern having a number of plants, and sent to the engineers in charge of them. Accompanying the sketch was a circular letter with instructions as to the use of soda ash and graphite, and the formula for the boiler compound formulated by the supervising engineer, with instructions for its use and the method of testing the boiler-feed water to determine when sufficient compound was being used. The illustration is self-explanatory, and the directions for using follow:

The expansion tank is placed above the water line of the open feed-water heater or return tank and piped as shown. To operate, put the amount of compound required for twenty-four hours, mixed with sufficient water to flow freely through the filler funnel, into the tank, valves *A*, *B*, *C*, and *D* being closed. Then put



PIPING OF COMPOUND FEEDER

more water in the tank to bring the level up to the overflow pipe. Next close valve *E* and open valves *B* and *C* and then the valve *D* just sufficient to keep the tank agitated and the condensation overflow through the pipe and valve *B* into the pump suction.

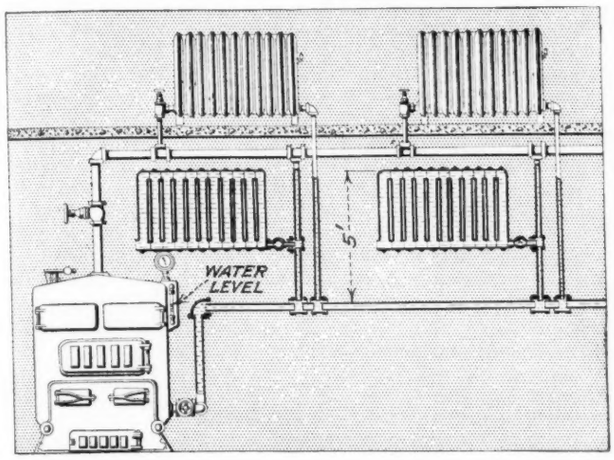
When it is necessary to refill the expansion tank, open valve *A* and allow sufficient liquid to flow into the pump suction to make room for the new charge. Then close the valves *A*, *B*, *C* and *D*, fill through the valve *E*, and proceed as before. W. T. MEINZER.

Brooklyn, N. Y.

Firing Low-Pressure Boilers

The theory presented by J. M. Coleman, on page 837 of the Dec. 10, 1918, issue of *Power*, regarding the peculiar action of some low-pressure boilers does not seem to me to be correct. Hard firing ought to make the water lighter as it would then be filled to a greater extent with globules of steam.

I recollect an instance somewhat similar to that related by Mr. Coleman. The owner of a building installed a sectional cast-iron heating boiler, but instead of excavating for the boiler setting in order to secure a head, as he had been advised to do, he saved the price and set the boiler on the floor. The result was that there was a head of not more than five feet. The radiators were equipped with motor-seal valves from which the floats had not been removed. The heating system had previously been used as a vacuum return. I knew the caretaker and advised him never, under any circumstances, to raise the pressure above about two pounds.



LOWER RADIATORS FLOODED WITH CONDENSATE

A "howl" was made for heat, however, and in order to be agreeable he raised the pressure. The result was a melted fusible plug and several cracked boiler sections. My reason for advising him as I did was that, as the motor-seal valves would permit nothing but condensation to pass, the effort of the pressure to equalize on both sides of the valves would hold the check shut until a sufficient head of water had accumulated to balance the boiler pressure plus the weight of the check.

As the water in the return had to rise only about five feet to be up to the top of the lowest coils, a large storage capacity was provided for the returning condensation, and the fireman happened to be away at the psychologic moment, or he might have kept the boiler supplied with water. He saw the reason when he had the proof and did not raise the pressure above two pounds again.

Toronto, Ont., Canada. R. McLAREN.

Was This Armature Burnt Out?

For approximately six years a 10-kw. three-phase 25-cycle converter had been in service twenty-four hours a day. In addition to the strain of such continuous service the location was very much against the machine. The converter was mounted above the switchboard frame in a storage-battery assembling and charging room. The air was filled with sulphuric-acid fumes and a heavy black smoke, the latter being given off by the pots of hot pitch. The armature was recently taken out and sent to a motor-repair shop to have the rings and commutator turned down. After turning the rings and commutator the motor foreman notified the owner that the armature winding was burnt out and would have to be rewound. On inspecting the armature I came to the conclusion that the winding had at some time been quite hot and that it had been impregnated with an insulating paint, which caused it to be very hard and give off a sound similar to that of a burnt winding, when struck with a light hammer. The armature was put back and the machine started in service. Everything went well for about an hour, when a flash was seen and the circuit-breaker opened. It was supposed that the armature had burnt out, but all the coils were cool.

The trouble was found to have been caused by a flash from a brush-holder to ground. When the insulation on the brush was cleaned, the former was found to have been carbonized by a slow leaking of current through the oil and dirt. The brush-holder was taken out and a piece of composition mica board heated and bent around the square part of the stud, the brush-holder replaced and the machine put into service. The converter is now carrying its load twenty-four hours a day without any sign of distress. R. L. HERVEY.

Washington, D. C.

Guide For Tube Cleaner

For removing scale from water-tube boilers I have been using a water-turbine cleaner. To enter the cleaner in a tube it was necessary to put one hand through an opening in the handhole plate to keep the cutter wheels together. Recently, a way was found to eliminate the work of guiding the cleaner by hand. A piece of sheet iron was shaped into a half-circle, the length being sufficient to project from the handhole plate a short distance into the tube. The outer end was flanged over and the device placed in the position shown in the illustration. It guides the cleaner right into the tube and prevents the wear of the hose on the sharp edges of the handholes. E. G. CARLSON.

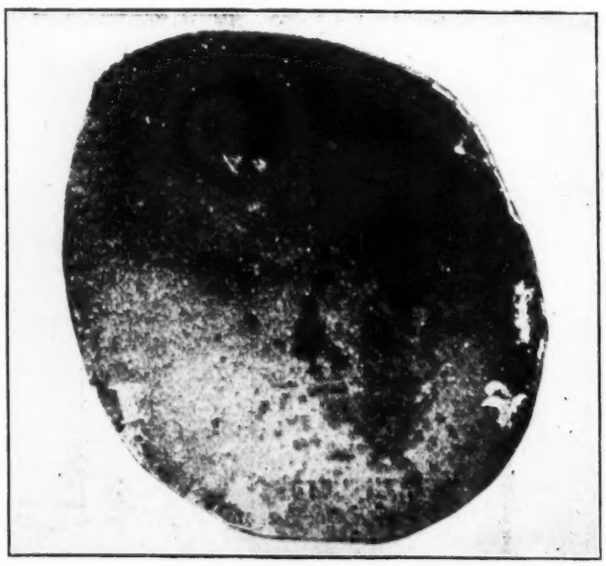
CLEANER GUIDE AND ITS APPLICATION

Chicago, Ill.

Comments on the Mobile Boiler Explosion

After reading the account of the Mobile boiler explosion and also the letters by E. R. Fish and A. G. Pratt, on pages 465 and 466 of the Mar. 25 issue of *Power*, in which the representatives of the two boiler manufacturers give their theories as to the cause of the explosion, each evidently believing that it was the other manufacturer's boiler that exploded first, permit me to comment on the evidence that has been presented.

First of all, suppose we consider another explosion, which occurred at the Marion Railway Light and Power Co.'s plant at Marion, Ohio, on Aug. 22, 1906. This was an explosion of a Stirling boiler, and the cause was undoubtedly the failure of the blank head on the bottom or the mud drum. This head was corroded, and the break occurred where the head dished the most in turning to make the flange. In this instance, as at Mobile, the boiler was one of a pair, each so set that the blank head of the mud drums came end to end. The accompanying illustration is a reproduction of a photograph



MUD-DRUM HEAD FROM MARION, OHIO, BOILER EXPLOSION

of the disk that was blown out of the drum head. The account was published in the *Engineers' Review*, then of Cleveland, Ohio. A comparison of this disk and the one shown in the article describing the Mobile explosion shows them to be almost identical, and the cause of both ruptures was due to corrosion of the head. This, it would seem, emphasizes the contention of Mr. Fish that the Stirling boiler mud-drum head failed first.

Coming back to the case in hand and discarding the theories offered by Mr. Fish and Mr. Pratt, an examination of the approximate plan of the plant offers an opportunity for speculation. As stated in the article, Nos. 4A and 4B Heine boilers were set in one battery, and Nos. 5 and 6 Stirlings were also set in one battery with a space between the settings of the two types of boilers. Assuming that No. 4B Heine exploded first, it would have been blown to the position shown, and No. 4A would have been blown to the position indicated in the plan view published with the article. If Stirling No. 6 exploded a few seconds later it would have been blown to the position shown at the Allis engine, but No. 5 boiler would not have been blown to the position shown as the result of the explosion of No. 6. As a matter of fact, it would have been blown toward the original setting of the Heine boilers, and in an opposite direction from that in which it really did go.

Working on the theory that the Stirling No. 6 was the first to explode, it would have been blown to the position shown, and the force of the explosion would have been such as to shatter and destroy the brick setting of No. 5 Stirling, which it did. Assuming that the Heine exploded a second or two after the Stirling, the results could be expected as were found.

It might be assumed that the force of the exploding Heine boiler would blow No. 5 Stirling to the position shown in the diagram, but the probabilities are that this boiler was blown to its final resting place by the skyrocketing effect resulting from the tubes pulling out of the mud drum.

The indications are, however, that the setting of boiler No. 6 was demolished before No. 5 was blown out of its setting, and if the flight of No. 5 was due to the pulling out of the tubes in the mud drum, it would seem that it would have been blown in the direction of No. 7 boiler, or at a right angle to the direction in which it did go. On the other hand, if No. 6 Stirling boiler exploded first and was followed by that of No. 4B Heine, together with the pulling out of the tubes of the mud drum of No. 5 Stirling, it would appear that No. 5 boiler would have landed just where it did. This would be due to the setting of No. 6 being totally demolished and out of the way and at the same time shattering the setting of No. 5 by the initial explosion of No. 6 boiler. If this was immediately followed by that of No. 4B Heine, the setting of No. 5 boiler would have been demolished from both sides at practically the same instant. The water-hammer set up in No. 5 boiler, due to broken steam connection and the flashing of water into steam, would cause the tubes of No. 5 boiler to pull out of the drum. As the setting of No. 6 boiler was gone, and with the Heine boiler exploding at practically the same instant that the tubes pulled out of the mud drum of No. 5 boiler, the force of the explosion would be to blow the latter to the position alongside of the Allis engine.

One fact regarding the Heine boiler should not be lost sight of, however; that is, that a portion of the back tube header is bent outward and that a part of it was found attached to the rear head of the steam drum, the rivets of which were sheared from the body of the drum. That the rear header was a point of initial rupture in this boiler is evident, and if the boiler was the second one to explode and its explosion was caused by the sudden release of pressure due to the explosion of the Stirling boiler, it would seem that the front header would have been the one to fail instead of the rear one. If, on the other hand, the rear header of the Heine boiler was the first to rupture, it would have been bent out as it was, and the ripping of the steam drum would have been a secondary result of the header failure.

The more one studies the problem the more it becomes evident that it is a difficult matter to determine which boiler failed first, as there are so many conflicting factors to consider.

W. H. ROWLAND.

New York City.

The Victory of Prosperity—The Victory Loan.

Inquiries of General Interest

Power Required To Drive an Emery Wheel—Will you publish the formula for figuring the power required to drive an emery wheel. G. L.

There is no method of figuring the power required to drive an emery wheel. However, the power required will depend upon the size of the wheel and the kind of work it has to do. Experience has shown that, ordinarily, a 6-in. wheel requires from 0.5 to 1 hp.; a 10-in. wheel, 2 hp.; a 12-in. wheel, 3 hp.; an 18-in. wheel, 5 to 7.5 hp.; and a 24-in. wheel, 7.5 to 10 horsepower.

Changing the Speed of a Fan Motor—Is it possible to increase the speed of direct-current motors used to drive fans? If so how is it done? A. R.

If a fan is driven by a series motor, the speed of the motor may be varied by connecting a resistance in parallel with the field winding. If the motor is of shunt type, its speed may be varied by connecting a resistance in series with the field winding. The value of the resistance will depend upon how much the speed is increased and upon the size of the motor. It is doubtful if a motor that has been designed to drive a fan of a given size can have its speed increased very much without being overloaded, since a fan load increases as the cube of the speed.

Excessive Size of Pump Suction Pipe—Can a suction pipe of a pump be too large where the length is about 200 ft. and lift 11 ft.? J. S.

The suction pipe should be large enough to keep the velocity of water down to about 230 ft. per min. By the use of a smaller pipe requiring greater velocity there is too much loss of pressure in overcoming pipe friction. The higher the vacuum required at the pump the greater the amount of air liberated out of the water, giving trouble in operation of the pump. On the other hand, when a larger suction pipe is used, there may be less pipe friction from lower velocity, but more time is given for liberation of air from water that is subjected to less than atmospheric pressure. However, the pipe cannot be too large for those portions where the pressure in the suction pipe is above the pressure of the atmosphere.

Why Equal Cutoff Requires Unequal Valve Laps—To obtain equal cutoff with an ordinary D slide-valve engine, why is it necessary to have less outside valve lap for the crank end than for the head end of the cylinder? C. R.

On account of the angularity of the connecting-rod, the first half of a stroke of the piston from the crank end of the cylinder is accompanied by more than one-quarter of a complete revolution of the crankshaft, and the first half of a stroke from the head end is accompanied by less than one-quarter of a revolution. Hence, for any fraction of stroke from the crank end the eccentric is carried through more degrees of rotation than for an equal fraction of stroke from the head end, and if the valve had equal laps, cutoff would occur earlier in the stroke from the crank end than from the head end, and in order to delay closure of the steam port on the crank end to the same fraction of stroke as cutoff occurs for the head end, it is necessary to have less lap of valve for the crank end.

Effect of Increasing Weight of Governor Balls—Would increasing the weight of the flyballs of an ordinary Corliss engine governor cause the engine to be regulated at a higher or a lower speed? I. W. C.

In operation of the pendulum type of governor ordinarily employed on Corliss engines, the arms from which the flyballs are suspended do not attain as great height as would be assumed by a simple revolving pendulum, because part of the centrifugal effort is employed in supporting a central weight, or in overcoming the elasticity of a spring, in addition to sustaining the weight of the balls and arms. Increasing the central weight, or, as well known, adding load to the governor, acts as a greater restraint that results in increase of speed. The cutoff becomes longer because the balls are in lower position for the same speed, and increase of speed continues until the centrifugal effect becomes sufficient to carry the additional burden laid on the governor. Evidently, the same result of speeding up the engine would result from making the governor balls lighter, but the reverse result is obtained either by taking load off the governor or by increasing the weight of the governor balls; that is to say, increasing the weight of the governor balls will result in slower speed of the engine.

Loss from Combustible Remaining in Ashes—What is the loss from combustible remaining in ashes when the coal as fired contains 12,890 B.t.u. per lb. and 12.6 per cent. ash, if the refuse contains 40 per cent. combustible and the coal costs $6.75 per ton? J. A. P.

Each 100 lb. of coal containing 12.6 per cent. ash would consist of $(1 - 0.126) \times 100 = 87.4$ lb. of combustible and 12.6 lb. of ash. If the refuse from firing consisted of 40 per cent. combustible and $100 - 40 = 60$ per cent. ash, then the refuse from firing 100 lb. of coal would contain $12.6 \div 60 \times 40 = 8.4$ lb. of combustible, and the loss of combustible contained in the coal would be $(8.4 \times 100) \div 87.4 = 9.6$ per cent. Hence, if the coal contained 12,890 B.t.u. per lb. of combustible, there would be a loss of 9.6 per cent. of $12,890 = 1237$ B.t.u. per lb. of coal; and with coal costing $6.75 per ton there would be a loss of 9.6 per cent. of $6.75 = $0.65 per ton of coal used.

Expressed algebraically, if a = percentage of ash in the coal and c = percentage of combustible in the refuse, then $100 - c$ = percentage of ash in the refuse and $\left(\frac{a}{100 - c} \times c\right)$ $100 \div (100 - a)$ = percentage of loss. If as in the example, $a = 12.6$ and $c = 40$, by substitution the formula becomes $\left(\frac{12.6}{100 - 40} \times 40\right)100 \div (100 - 12.6) = 9.6$ per cent. loss.

Operation of an Induction Generator—Will you explain the operation of a squirrel-cage type induction motor when operating as a generator as sometimes used in semiautomatic hydro-electric power plants? J. T.

When a squirrel-cage type induction machine is operating as a motor, its rotor is running slower than the revolving magnetic field and is cutting this field in a direction to set up a current in the rotor of a direction to produce a torque in the same direction as the field is moving. This rotor current is in an opposite direction to the stator current, consequently when operating as a motor the rotor current is a demagnetizing current, which will tend to decrease the strength of the magnetic field and therefore the value of the counter-electromotive force in the stator.

If power is applied to the rotor, as in the case of the induction generator, and driven faster than the revolving magnetic field—that is, above synchronism—its conductors will be cutting the line of force in a direction opposite to that when running as a motor. Therefore, if when operating as a motor, the current in the rotor is a demagnetizing current, and tends to reduce the counter-electromotive force in the stator winding, then when operating as an induction generator, the current in the rotor will be a magnetizing current and will increase the flux, causing the counter-electromotive force to increase above the applied voltage, and the machine will become a generator supplying current to the circuit to which it is connected instead of taking power.

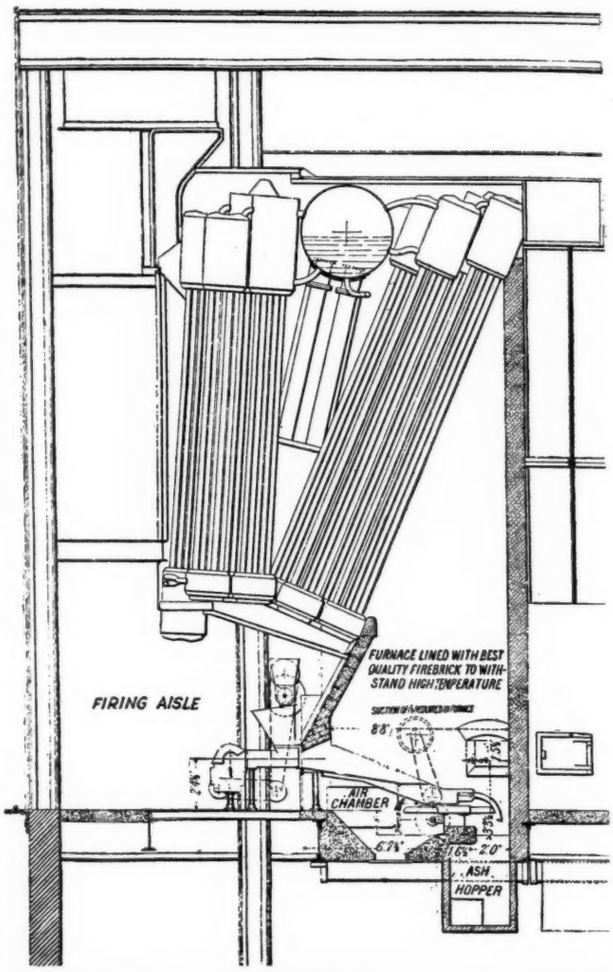
Hornsby Boilers Reset for Stokers

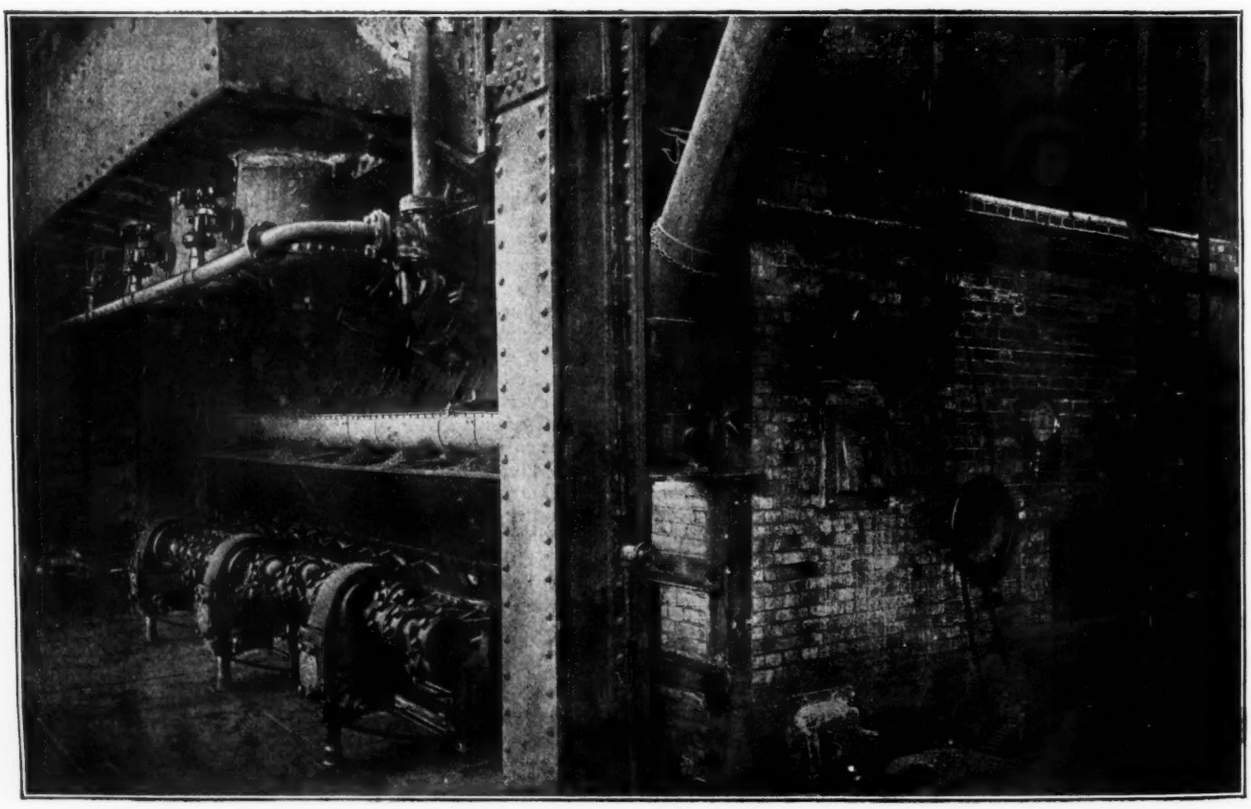
The Erith-Riley stoker has been specially developed for working in conjunction with large boiler plants installed on the unit system, and one of the latest examples is the installation of large-unit stokers at the Bow Power Station of the Charing Cross, West End and City Electricity Supply Corporation, Limited, fitted to the Hornsby vertical-type water-tube boilers.

The settings and grates of these boilers were originally arranged for hand-firing; the mechanical stokers have only just been fitted, and under the present system of working each boiler is run as a separate unit. The boilers have vertical tubes with steam drums at the top and mud drums at the bottom, with the casing set back and a space in the front for the withdrawal of the tubes. Each boiler has a total heating surface of 10,850 sq.ft. and occupies about 506 sq.ft. of floor space. The steam pressure is 180 lb. per sq.in. and superheaters are included in the equipment. The rated evaporation of each boiler is 33,000 lb. of steam per hour when fired by hand, but higher duties have been obtained; in fact, a pair of the boilers has easily provided under normal working conditions the steam for one of the 4,000-kw. Sulzer-Lahmayer sets.

The halftone shows the boiler in elevation, and gives a clear idea of the general layout of the stokers and the combustion chamber. It should be noted that there is no arch in the combustion chamber, which is an important matter when high-temperature combustion is being maintained, and that the firebrick lining on the face of the combustion chamber runs straight across and, due to its inclination, had to be fixed to the casings by special means.

Each boiler is equipped with its own operating plant, which comprises an electrically driven fan for the air supply to the furnace, a variable-speed motor for driving the stoker gears, and means for regulating by hand the amount of opening of the ash plate. These, with the necessary adjuncts on the stoker gears, are provided to secure independent control of the unit and the economical working of the plant and, further, safety attachments are introduced to reduce the effect of breakages to a minimum.—*Engineering* (London), Feb. 28, 1919.

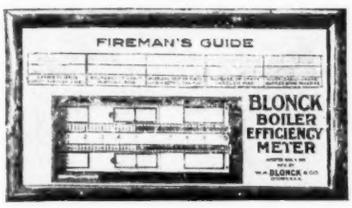




Condensed-Clipping Index of Equipment

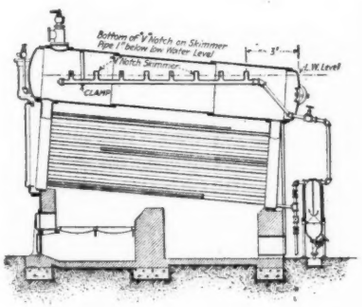
Clip, paste on 3 x 5-in. cards and file as deired

Meter, Improved Blonck Boiler-Efficiency
W. A. Blonck & Co., Chicago, Ill.
"Power," Feb. 11, 1919



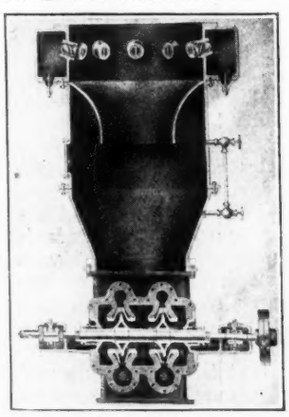
This new meter is designed so that the indicating oil columns stand one over the other for the highest efficiency of combustion. The fireman needs only to manipulate the dampers and the thickness of the fuel bed so as to maintain the columns of oil in line. When they get away from each other, the fireman simply refers to the guide printed on the face of the gage, determines what the trouble is and institutes corrective measures.

Skimmer, Yarway Automatic Boiler
Yarnall-Waring Co., Chestnut Hill, Philadelphia, Penn.
"Power," Feb. 4, 1919



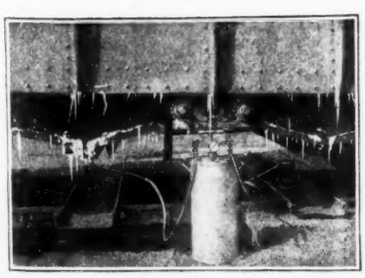
Skimmer consists of a skimmer pipe and is placed in a boiler a little below the water level. Water and scum circulate into and through a precipitator placed outside of the boiler, and in which the scum is separated from the water, which then returns to the boiler through the blowoff connection. The skimmer is designed for various types of boilers. Skimmer consists of vertical pipe made with a V-notch opening on one side and arranged to alternate.

Condenser, Elliott-Ehrhart Jet
Elliott Co., Pittsburgh, Penn.
"Power," Feb. 4, 1919



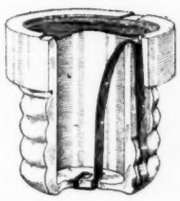
Jet condenser, vertical type. Spray nozzle in condenser head breaks water into small particles so as to properly mix with the steam. Inspection openings provided in the lower surface of the overhanging condenser head. Steam ejector removes air. Centrifugal pump handles condensate.

Thawing Outfit, Aeroil
Aeroil Coal-Thawing Outfits, Inc., 1 Broadway, New York City
"Power," Feb. 25, 1919



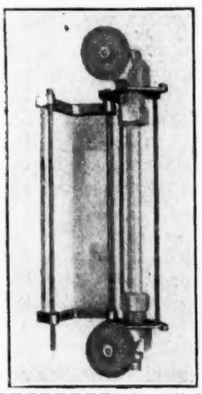
This thawing outfit is designed to thaw frozen coal cars, especially the hopper gates of hopper-bottom type. It consists of a 10-gal. capacity steel tank equipped with a power air pump, pressure gage, air-release valve and oil-regulating valve. Two 8-ft. lengths of hose with unions and two extension pipes with connection, also two thawing burners complete, are supplied. Outfit burns kerosene oil, rate 2 to 5 gal. per hour. It is portable.

Fuse, Refillable Plug
A. F. Daum, Pittsburgh, Penn.
"Power," Feb. 11, 1919



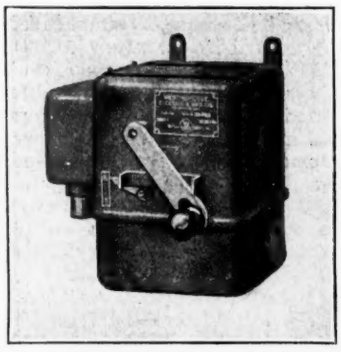
The only metal part of this refillable fuse plug is the fuse metal. The metal thread, base plug and part of the cap used in the old type non-refillable fuse have been eliminated. There are but three parts to this fuse—a porcelain base, a mica cap which can be removed and replaced to fill the fuse, and the fuse metal. Made in sizes from 3 to 30 amp., for 125 volts circuit.

Shield, Durable Gage-Glass
Durabla Manufacturing Co., 114-118 Liberty St., New York City
"Power," Mar. 4, 1919



Device consists essentially of two laminated glasses set in cast retainers, forming a V-shaped protector over the front of the gage-glass. Shield is hinged to water gage. Protecting plate made of laminated glass 3 in. thick, 2 in. wide, and of length varying to meet requirements. All metal parts are of brass.

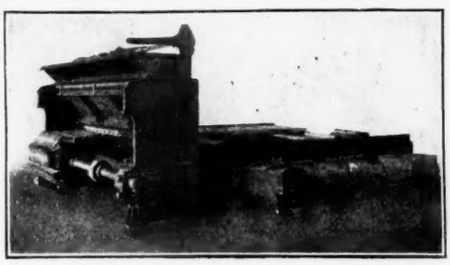
Switch, Quick-Make Starting
Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn.
"Power," Feb. 4, 1919



Switch is designed to be used with three-phase, 220-, 440- and 550-volt squirrel-cage motor of from 2.5 to 25-hp. capacity. Starts with full line voltage. Can also be used to control feeder circuits up to 100 amp. capacity. Switch is especially suitable for shipper-rod operations. Contacts are opened and closed in oil to suppress arcing.

Harrington Forced-Blast Traveling Grate
James A. Brady Foundry Co., Chicago, Ill.
"Power," Mar. 11, 1919

This is a chain-grate type of stoker and is designed for either natural or forced draft. Another feature is that the grate surface is nonsifting and grate bars slide easily over the ends of the racks. An adjustable damper controls the air pressure in the respective compartments. The closing of the damper and the removal of a door at the end of the communicating passages to the side wall, puts the stoker on its natural-draft basis. A reversal of this process converts it to a forced-draft stoker.



Patented Aug. 20, 1918

Coal Accounting in the Boiler Room*

One of the things which the war has taught us is economy, and what we learn from dire necessity is likely to be profitable. Last winter, and in fact until very recently, people had to burn less coal simply because it could not be procured readily. The problem of making a smaller amount do the same work resulted in careful examination of all possible economies, and in this effort the Fuel Administration took a prominent part.

Their very first recommendation, and of course the foundation stone of all economy, was coal accounting in the boiler room, and this is a subject deserving of attention, not only for the reasons stated, but because the stress of competition is going to require the greatest possible conservation of energy.

The simplest boiler room, of course, is hand-fired from the floor. Coal is delivered by one of several methods. Sometimes the floor is a sufficient distance below the adjacent railroad siding to allow the coal to be dumped almost to the edge of the boiler. Sometimes the coal pile is outside the plant and the fuel has to be transferred to the boiler room in wheelbarrows; and some large plants adopt this method. There have been three or four concerns in the last few years which have considered bringing coal into the plant with screw conveyors.

Then there is the little industrial car running on tracks in front of the boilers, and this, and even the wheelbarrow, can be weighed if desired. Platform scales with a flush platform have been used for years in this service, and they are improved occasionally by adding dial records.

Development of the Overhead Bunker

The inconvenience and discomfort of having coal on the floor, involving also a large item of labor, led conveyor engineers to develop the various bucket, scraper and belt conveyors with which we are all familiar. This brought about the overhead coal bunker, and immediately two schools of thought sprang up. Both were anxious to determine the amount of coal used, but the first maintained that it was sufficient to know the total quantity delivered to boiler room, while the second insisted that the consumption of each individual boiler was still more important and afforded, of course, by simple addition the other result which was desired by everybody.

With an overhead bunker, continuous in front of all the boilers, the easiest way to determine the total coal delivered to the boiler room is to weigh it as it goes into the bunker, either with a conveyor weightometer or with a large automatic scale. Sometimes, indeed, plants content themselves with taking the bill of lading of the shipper as indicative of the amount of coal received, and plants on the the waterfront will even accept the shipping weight of barges. These two plans are inaccurate, and errors as great as 8 per cent. have been found.

Plants weighing coal as it goes to the bunker sometimes have painted lines at different heights on the bunker and once a month level off the coal to these lines and so feel pretty sure that they know exactly how much coal they are using. Such determinations, however, can be only approximate and cannot give the amount of coal used in a shift of eight hours or in any time short of a month, let us say. Advocates of total coal delivered to the boiler room are better served when they do not have the overhead continuous bunker, but in its place a vertical bunker at one end of the plant, not unlike a silo. Under this the automatic scale can be placed, dumping 1000 or 2000 lb. for example, and under the scale a lorry car of one sort or another can be run and the operator can take one, two, three or four dumps of the scale as he pleases and run back to the boilers. This method will give the total coal per shift, and under certain circumstance some approximation of the individual consumption of each boiler can be obtained by keeping a careful record.

The second school of thought held that a record of the individual boiler was of prime importance. I think it fair to say that a majority of engineers today incline to this view. It seems quite reasonable that, since coal is approximately 60 per cent. of the cost of the output of a plant, it should be determined with the utmost care, but in addition to individual boiler scales, there are individual pyrometers for determining temperatures in the uptake and recording them on a chart, individual draft gages indicating uniformity of thickness of fire beds, individual CO_2 recorders showing that each fire is producing the proper percentages of the products of combustion and, lastly, the individual indicating and recording flow meter giving the steam output of each unit. Most of them have reached practical, reliable application only within the last five years.

Long before any of these accuracy devices were developed, however, and in fact as soon as overhead bunkers were put into plants, various efforts were made to determine the total coal delivered to the boiler room. Some of these were on the volumetric principle, but with them it becomes necessary to translate the cubical capacity of the container to an equivalent weight and, manifestly, this depends upon the fineness to which the coal is crushed and also upon the percentage of moisture.

Bridge Cranes and Traveling Lorries

In large central stations one frequently finds a bridge crane with a man riding around in it. He runs the crane under any desired bunker opening, puts in an unknown quantity of coal, weighs it up on a hopper scale, generally provided with a registering beam, then runs to the desired boiler and dumps the coal. What these big stations want most to know is the total coal delivered to the boiler room per shift, so they can figure out their coal per kilowatt-hour each day.

The younger brother of this big traveling crane is the traveling lorry with the suspended beam box. Frequently this is hand-propelled, and one source of error lies in the fact that the operator often pushes it along by the beam box instead of operating the chain wheel overhead, thus throwing out of adjustment the strut and tension members. These traveling lorries have many apparent advantages, however, and are frequently seen. They do not cost very much; they are portable and can always be moved aside when it is desirable to get at a boiler to clean it or pull a tube; they permit poking a slice bar up into the bunker opening in case of stoppage, and they can also be used to transport coal from one part of the bunker to a boiler at the other end of the room.

Stationary automatic boiler scales equipped with automatic counters represent a high development in the compiling of records of coal burned by individual boilers. They give a continuous record in plain figures, understandable by anybody, and hourly comparisons of coal burned with steam output can be made if desired, although the comparison of consumption on different shifts is more customary. Scales designed for continuous operation discharge coal as fast as it is taken away by the stoker and so involve no responsibility for seeing that there is ample coal to carry the station over its peak. Mounting the scales on carriages or even flanged wheels permits easy removal when it is necessary to clean boilers.

*Abstract of a paper read by B. K. Hough, M. E., at the annual convention of the Richardson Scale Co., Jan. 3, 1919.

Utilization of the large peat areas in the north part of Jutland is receiving much attention. The area is said to be as much as 28,000 acres, which, according to *Ingenioren*, could be completely drained by gravitation, and the total contents might be equivalent to 23 million tons of coal. It is suggested that the peat could be utilized (1) as air-dried briquets used for heating the boilers of adjacent electrical supply works; (2) as machine made briquets sold for general consumption as far away as the cost of transport will allow; (3) as peat litter to be sold to neighboring farmers; (4) the lower parts of the bogs should be reclaimed and used for agriculture. The heating value of the peat is assumed to be half that of coal. The works required should be executed by private enterprise, aided by the State, and the cost of reclamation would amount to £50,000 ($243,325). The first 9000 acres could be dealt with in twenty years, and the rest of the land occupied in course of time as the peat is cleared away.

Engineers Discuss the Oil Engine

"Adapting Fuel to the Engine versus Adapting the Engine to the Fuel" was the general topic discussed at a joint meeting of the New York local sections of the A. S. M. E. and the S. A. E. held at the Automobile Club on Wednesday evening, Apr. 9. There was an unusually large attendance, representing automobile, stationary and marine fields. Dr. Charles E. Lucke, who presided, reviewed the present oil-fuel situation and the accompanying tendencies in oil-engine design. In an effort to meet the greatly increasing demands for gasoline the producer is making every effort to extract more from the crude oil with the result that the extracted product is becoming heavier and heavier and trouble is frequently experienced with engines designed for the lighter grades. Whether the heavy-oil engine will be developed for automobile and tractor use is still an open question in the opinion of the speaker. As a solution to the use of the lower-grade gasoline, some advocated preheating the mixtures, but this, Dr. Lucke pointed out, meant less power. In the earlier hot-bulb engines he explained there seldom was complete vaporization of the oil. This led to spraying and late injection, which is now recognized as fundamental in the handling of heavy oils.

The first paper was that by J. P. Smootz, of the Bureau of Mines, who talked upon some of the problems of the chemist in an effort to keep pace with increased demands, and gave some figures of recent production.

J. H. Hunt, of the Dayton Engineering Laboratories, next told of some of the investigations there being conducted. He was of the opinion that too little coöperation exists between the oil producer and the automobile manufacturer. The former is marketing gasoline of ever-increasing density, and the latter is attempting to use it in an engine designed for the lighter grades. Much of the trouble is experienced in starting when the engine is cold. With the "choke" in, a rich mixture is drawn into the carburetor and intake manifold and is only partly vaporized, consequently particles of the heavy products are drawn into the cylinders and when an explosion takes place, cracking results. Not only does this form carbon, but the products cut the cylinder lubrication, causing excessive wear and fouling of the crank-case oil with carbon and water. Another effect of the cracking is the setting up of severe knocks, which the speaker attributed to excessive pressure or detonations rather than the commonly accepted theory of preignition. Investigations so far have indicated two remedies: First, the use of a lighter oil for starting, and second, heating the mixture. The former involves the carrying of two fuels with the attendant difficulty of securing a tight needle valve, and the second involves decreased volumetric efficiency and power.

A paper by A. H. Goldingham, of the De La Vergne Machine Co., on the heavy-oil engine was next read by the chairman. The author drew attention of the reliability of the present well-designed hot-surface type and attributed such performance to the more thorough atomization due to more efficient spraying devices and pumps, to improved construction of the vaporizing chamber, vaporizing lamp and lubrication of the parts. Engines of this type are now being made in sizes from 10 to 400 hp., the largest cylinder without piston cooling being 21 in. in diameter and 900 ft. piston speed. The cost of such engines has practically doubled since 1913. Statistics showed that of a large number of these engines in use about 42 per cent. were in pumping installations, 19 per cent. in electric-light plants and the remainder in general use.

T. O. Lisle, editor of *Motorship*, next told of some of the applications of the heavy Diesel to marine practice. He believed the Shipping Board had been remiss in not prescribing more extensive use of the Diesel engine in ships of the emergency fleet. While it was true that Diesel engines had been installed in some of the wooden ships built on the Pacific coast, this in Mr. Lisle's opinion had not been a fair trial, as the ships were in most cases underpowered and this necessitated overloading the engines continually. Also, the ships of the emergency fleet have had to deal with inexperienced labor in so far as the operation of Diesel engines is concerned, and this perhaps had much to do with some of the troubles encountered. He referred to a motor cargo ship laid down by the British Admiralty during the war, which was over 400 ft. long, had two engines with a total of 6000 hp. and designed to attain a speed of 15 knots. Sulzer Bros. had also constructed a 4000-hp. six-cylinder land engine, which is now running in France. Of eighty-six firms building Diesel engines forty-two are constructing the four-cycle, thirty-three the two-cycle and the remainder both types.

Mr. Hanson, of the Skandia Engine Co., taking part in the discussion, referred to the Diesel engines installed in the wooden ships on the Pacific coast. Numerous troubles had been encountered, he said, but these were primarily due to the wooden ships themselves. In many cases green timber had been used in their construction with the result that the bedplates had shrunk and had thrown engines out of alignment. Most of these engines had been for auxiliary power and were rated at 100 to 500 hp. each, although a full Diesel-type engine of 1000 hp. had recently been installed in one of these Pacific-built ships.

Discussing the heavy Diesel, Harte Cooke, of the McIntosh & Seymour Corp., stated that less trouble had been experienced with the very heavy fuel oils than with the lighter grades because the lighter grades contained some kerosene which would crack and result in carbon. This, however, could be rectified by arranging the fuel valve so as to have a lower temperature. With oil above 40 deg. gravity care has to be taken to avoid cracking. Oil heavier than 14 deg. is hard to handle without heating, in which case care must be taken not to throw down the lighter products. Some troubles with cylinders skipping after having been in service for several days were finally traced to the fuel-pump intake at the bottom of the oil tank. When the oil had become low in the tank, the pump had begun to draw sediment, some of which had passed through the strainer and caused trouble in the fuel valves.

Electric Drive on U. S. S. "New Mexico"

Particular interest centers around the propelling machinery of the U. S. S. "New Mexico," which has recently been commissioned and which is not only the largest and most powerful ship in the Navy, but the first battleship to be electrically driven. The following particulars are from data prepared by E. Berg, of the Turbine Engineering Department, General Electric Company.

The propelling machinery consists of two main turbo-generator units, four propelling motors, each direct-connected to a shaft, motor-driven circulating pumps, air pumps, hotwell pumps, lubricating pumps, blowers for ventilating fans and the necessary switchboard panels, etc. The total weight of this apparatus, together with spare parts, is approximately 590 tons, and the contract price, $431,000.

The main generators are two-phase two-pole 35-cycle machines, rated at 10,500 kw. at 78 per cent. maximum power factor, with an overload capacity of 25 per cent. at the same power factor, the maximum rotative speed being 2100 r.p.m. The propelling motors are of the induction type arranged for two speeds with 24- and 36-pole connections. The speed reduction between the generator and motor when using 24 poles is 12 to 1, and with the 36-pole connection 18 to 1.

The windings of the generator can be connected in multiple by means of a switch so as to reduce the voltage from 4240 to 3000, which increases the current capacity of the generator and also gives increased torque and better efficiency.

For all conditions of steady running up to about 15 knots, only one turbo-generator with the low-voltage connection is used and all of the motors connected for 36 poles. If a slightly higher speed is required, the pole connections are changed from 36 to 24, giving a speed ratio of 12 to 1 and a speed of about 17 knots, with only one generating unit. Above that speed and up to the maximum speed of the ship, over 21 knots, the second generating unit is thrown in. When both turbo-generators are in use, the high-voltage connections are employed and each serves a pair of motors, with the two circuits entirely separate.

All reversing is done with the motors connected for 36

poles. During the trial run with the boat making 21¼ knots, reversal to full speed astern (two-thirds of the forward speed) was attained in 20 seconds.

When operating at full load and approximately 2000 r.p.m., each generator requires 38,000 cu.ft. of ventilating air per minute. The blowers are installed in a room directly above the generators; they receive air from the deck and force it through ducts into large inclosed compartments directly under the generators. After passing through the generators, the air is discharged from the top and carried upward to the deck. Each generator is served by two blowers, each capable of delivering 20,000 cu.ft. of air per minute when operating at 380 revolutions per minute.

The table shows the steam economies of the turbine. It will be noted that the official report of the board that ran the trial gives water rates somewhat higher than those guaranteed. This is explained by the fact that the water rate of a ship is not judged from the readings from electrical instruments, but is calculated from the revolutions of the propeller as previously compared with the readings of torsion meters on the shafts during standardization runs on a measured mile.

	Water Rate, Lb. per Shaft Hp.-Hr.			
	Full Speed	19 Knots	15 Knots	10 Knots
No. 1 Trial Report	12.29	11.926	11.667	14.223
Results indicated by readings of electrical instruments	12.30	11.55	11.35	14.35
Guarantees reduced to trial conditions	11.67	11.03	11.495	15.28
No. 2 Trial Report	12.01	12.196	12.482	14.22
Results indicated by readings of electrical instruments	11.58	11.50	11.60	14.35
Schenectady test reduced to trial conditions	11.00	11.08	11.16	14.25
Guarantees reduced to trial conditions	11.31	11.184	11.45	15.28

Managing director Isaacs of the Marconi Co. says that experiments in a new type of wireless telephone are so far advanced that within a few weeks it will be possible to speak between London and New York, while the establishment of a regular commercial service by wireless telephone between London and New York early next year is expected. Early realization of portable pocket wireless telephone is also foreshadowed.

Delaware Has a Board of Boiler Rules

On Apr. 8 Gov. John E. Townsend, Jr., signed a bill which had been passed unanimously by the House and Senate, providing for the safety of life and property in the State of Delaware, establishing a Board of Boiler Rules and prescribing rules and regulations for the boilers used in the state, which shall be uniform with other state rules now in existence in order to provide for the free interchange of boilers between states. The act defines the power of the Board of Boiler Rules, provides penalties for the violation of the act and the rules and regulations of the Board of Boiler Rules, and makes an appropriation for the carrying out of the provisions of the act.

The Governor is to appoint a board of five citizens of recognized knowledge in the construction and use of steam boilers, who shall act as members of a Board of Boiler Rules. These five citizens shall preferably be, one a professor of mechanical engineering, another a manufacturer who shall have been actively engaged in the manufacture of steam boilers, another a user of steam boilers, another a mechanical engineer and the fifth a licensed stationary engineer. The terms of such members shall be five years each, and they shall be so classified, but one shall be appointed each year. The rules and regulations so formulated shall be as nearly as possible in conformity with the Boiler Code of the American Society of Mechanical Engineers.

Shipping Board Lets Large Oil Contract

Contracts for 7,500,000 bbl. of fuel oil for delivery at Atlantic and gulf ports during the next twelve months, says the Washington *Post*, were awarded last week by the Shipping Board. All bids for Pacific coast delivery were rejected as unsatisfactory.

Contracts were entered into with the Standard Oil Co. of New Jersey for 3,500,000 bbl. delivered at New York, 1,500,000 bbl. at Norfolk, and 500,000 bbl. at Baltimore, and with the Standard Oil Co. of Louisiana for 2,000,000 bbl. delivered at New Orleans.

The Shipping Board in February invited bids for a total of 34,000,000 bbl. of fuel oil for the year beginning Mar. 1; the contracts just let are the first of these bids accepted.

Obituary

J. E. Johnson, Jr., mining and consulting engineer, 52 William St., New York City, died on Apr. 4 as the result of an automobile accident. Mr. Johnson was born at Long Dale, Va., in 1870. He received the degree of M. E. at Haverford College in 1891 and M. M. E. at Cornell University in 1892. He has been connected successively with the Baldwin Locomotive Works, the Straight Line Engine Co., Oswego Machine Works, Long Dale Iron Co., and Sanderson & Porter. He was a member of the American Society of Mechanical Engineers and a director of the American Institute of Mining and Metallurgical Engineers.

Personals

F. V. Sargent has been appointed by the Chicago Pneumatic Tool Co., as district manager of sales in the Boston territory, succeeding F. S. Eggleston, with headquarters at 182 High St.

First Lieut. S. A. Koenig, of the Coast Artillery, has been discharged from the Service and has joined the forces of the **Advance Machinery** and Supply Co., Denver, Colo., as sales engineer.

Prof. Comfort A. Adams, who is president of the American Institute of Electrical Engineers and was recently elected president of the American Welding Society, has been chosen dean of the faculty of the Harvard School of Engineering at Cambridge, Mass.

Major Carlisle Mason, having resigned his commission in the United States Army, will resume the practice of general engineering in a consulting capacity at 207 Broadway, New York City, assisted by a staff of experts in the specialized branches.

Paul T. Buckler, who was formerly New York representative of the Detroit Stoker Co., and was a lieutenant in the Navy throughout the war, has returned to take up again the sale of the Detroit "V" Type Stoker in the New York territory.

Col. Peter Junkersfeld, who received his discharge from the army Mar. 4, 1919, resigned on Mar. 31 as assistant to the vice president of the Commonwealth Edison Co., Chicago, in charge of contract, operating, electrical and construction departments, to become engineering manager for Stone & Webster. For over 23 years he had been employed continuously by the Commonwealth Edison Co. and its predecessors. He was graduated from the school of electrical engineering of the University of Illinois in 1895. The postgraduate professional degree of electrical engineer from the same university was conferred upon him in 1907. When the war broke out he was one of five reserve majors who were called into service early in June, 1917, and assigned to the office of the cantonment division, which a few months later developed into the construction division of the Army. The duties to which Mr. Junkersfeld gave his principal attention were "to direct the constructing forces in the field, and to advise and direct the commercial relations of the construction division of the army." Of these five men, four remained in the service throughout the period of the war, attaining higher rank, and handling during their service construction work of almost every conceivable character in the United States, amounting to around $800,000,000. Mr. Junkersfeld entered this work with the rank of major, and attained the rank of colonel in nine months after he was called into active service.

Engineering Affairs

The Detroit Engineering Society will hold its annual meeting on Apr. 19, followed by a banquet in the evening in the Auditorium of the Detroit Board of Commerce.

American Society of Mechanical Engineers, Boston Section, will hold a meeting on the evening of Apr. 17, at the Engineers' Club, 2 Commonwealth Ave. Prof. Lionel S. Marks, of Harvard University, Consulting Engineer, Science and Research Division, Bureau of Aircraft Production, will present a paper on "Some Aircraft Projects for the 1919 Campaign." A buffet supper will be served at 6 p. m., and the meeting in the auditorium will begin at 7.30.

Business Items

Charles F. Ames & Co., Ltd., 90 West St., New York City, have been appointed to act as the New York sales department of the Platt Iron Works, of Dayton, Ohio.

The Chicago Pneumatic Tool Co. has discontinued its office at Wichita, Kan., and the stock has been transferred to the new office and warehouse at Eldorado, Kan. Another office has also been opened at 313 Richards Building, Tulsa, Okla., with warehouses at 102 North Cheyenne St.

The Sullivan Machinery Co. has recently organized a Foreign Trade Department at its headquarters in Chicago, with F. W. Copeland, who was formerly attached to the St. Louis office, as manager. This department will coördinate and assist the work of the foreign branches and agencies of the company, and will give particular attention to correspondence and inquiries from abroad.

Badenhausen Co., Philadelphia, announces the opening of additional sales offices at Pittsburgh, 311 Jenkins Building, under the management of A. D. Neeld,, Jr.; and at Chicago, 1225 Marquette Building, under the management of J. F. O. Stratton. Inquiries from their respective localities will be handled by these men.

The Wetmore Reamer Co. is the new name of the Wetmore Mechanical Laboratory Co. of Milwaukee. The company has completed all its contracts with various munition makers of Canada and this country and has resumed its tool business. More floor space has been added and the offices enlarged. P. H. Dorr, recently released from the Government service, is secretary and sales manager.

Paul W. Koch & Co., Chicago, has been organized to take over the charter of the Electrical Sales Engineers, Inc., and combine that company with Koch & Sandidge. The company will act as sole distributor of the "Jiffy" adjustable cutter, which, in the past, has been marketed by Koch & Sandidge. In addition some new patented "Jiffy" tools will be marketed. The new company will act also as Chicago district representatives of the Condit Electrical Manufacturing Co., of South Boston, Mass.; the Esterline Co., of Indianapolis, Ind.; and Lewis & Roth Corp., which lines were marketed formerly by the Electrical Sales Engineers, Inc.

The Steam Motors Co., Springfield, Mass., has appointed Raines Kessler and Louis Lanyi to transact business under the name of the Engineering Service Sales Co., as its New York representatives with offices at 8 West 40th St., for the territory comprising the eastern portion of New York State, the northeastern portion of Pennsylvania, the northern half of New Jersey, and Connecticut west of the Connecticut River. Mr. Kessler was for a number of years connected with the Terry Steam Turbine Co., being for a time its Chicago manager, and more recently has been connected with the Green Fuel Economizer Co. at New York. Mr. Lanyi has been connected with the Green Fuel Economizer Co. for several years as the chief engineer of its fan division and has specialized in the design and application of high-speed, high-efficiency blowers for use in industrial and power station work.

Trade Catalogs

Expansion Joints. Howard Iron Works, Buffalo, N. Y. Catalog X-J-2. Pages 24, 6 x 9¼ in. Describing Howard joints in the guided and semi-guided types, single and double, with and without anchor base and service outlets.

The Badenhausen Co., Philadelphia, Penn., has issued Bulletin 101, entitled "Tests," giving full details of tests on Badenhausen high-efficiency preheater type boilers installed at the Ford Motor Co's. plant in Detroit. The pamphlet should interest operators of large boiler installations where economy and low cost of operation and upkeep are appreciated. A copy may be had free upon request.

The Leeds & Northrup Co., of Philadelphia, Penn., has issued a new bulletin entitled "Checking Thermocouple Pyrometers." It discusses the importance of maintaining standards and of checking in pyrometry. It points out sources of error and the remedies for troubles in thermocouples, millivoltmeters, cold junctions and potentiometers. It outlines a commercial checking laboratory, including a special checking furnace, precision potentiometers and standardized thermocouples. It is distributed free of charge and should be in the hands of every manufacturer, the quality of whose product depends upon temperature control by pyrometric means.

The Air Reduction Sales Co., New York City, has issued the following: Booklet No. 2, entitled "How To Start Airco-Vulcan Torches and Equipment." This supplies sufficient information to make it easy for an operator to quickly and correctly connect up these torches and regulators, and to operate them properly. Booklet No. 3, entitled "An Airco Achievement—Reclaiming Railroad Frogs by the Oxyacetylene Process." This describes the oxyacetylene process of welding and cutting metals and shows evidences of the success of the method of making repairs in some of the railroads of the country. Three leaflets issued also by the company are: "Airco Acetylene Generators," "Built Up Rail Frogs," and "Airco Service."

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.80@3.35
Philadelphia, gross tons	4.20@4.90	5.00@5.40
New York, gross tons	4.50@5.25	5.35@5.80
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.65

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$5.95	$7.80	Pea	4.80	6.55
Egg	5.85	7.70	Buckwheat	3.40	5.15
Stove	6.10	7.95	Rice	2.75	4.50
Chestnut	6.20	8.05	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.80 @ 3.10	2.95 @ 3.25
Clearfield County	2.65 @ 2.95	.....
Reynoldsville	2.65 @ 2.85	2.85 @ 2.95
Quemahoning	2.85 @ 3.10	2.95 @ 3.10
Somerset County (best grades)	2.75 @ 2.95	2.95 @ 3.10
Somerset County (poorer grades)	2.40 @ 2.75	2.75 @ 2.95
Western Maryland	2.50 @ 2.75	2.65 @ 2.85
Fairmont	2.10 @ 2.35	2.35 @ 2.50
Latrobe	2.10 @ 2.25	.....
Greensburg	2.35 @ 2.40	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.65 @ 2.75
Westmoreland run-of-mine	2.40 @ 2.65	2.40 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	5.85	7.70	Rice	2.75	3.65
Stove	6.10	7.95	Boiler	2.50	3.50
Nut	6.20	8.05	Barley	2.25	3.15
Pea	4.80	6.40	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@ 2.50	3.00
Screenings	1.85@ 2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.8 @$4.50
Corona	3.40
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....
Williamson County Prepared sizes, lump, egg, nut	$2.55	$2.55
Mine-run	2.35	2.20
Screenings	2.20	2.05
3-in. lump	....	2.30
2-in. lump	....	....

	$1.90@2.25
	2.00
	1.75
	.....
	2.15

Williamson-Franklin rate to St. Louis is $1.07½ other rates 92½c.

New Construction

PROPOSED WORK

Mass., Dorchester—The Upham Market Co. will install a steam heating plant, refrigerating machines and conveyers in the 2 story, 84x117 ft. market which it plans to build on Ramsey St. Total estimated cost, $100,000. W. M. Bacon, 27 Kilby St., Boston, Arch.

Mass., Worcester—Higgins & Fitzgerald, 840 Main St., will install a steam heating plant and vacuum cleaning system in the 3 story, 40x125 ft. apartment hotel which they plan to build on West Elm St. Total estimated cost, $125,000.

Conn., New Haven—The Chapel Street Ecclesiastical Society, Whitney St., will install a steam heating plant in the 2 story, 76x130 ft. parish house which it plans to build. Total estimated cost, $100,000. W. S. Cady, 40 West 32nd St., New York City, Arch.

Conn., Stamford—C. E. Slawson, Canal St., will install a steam heating plant in the 3 story, 128x150 ft. grain warehouse which it plans to build. Total estimated cost, $150,000. Thompson-Binger, 280 Madison Ave., New York City, Engr.

N. Y., Brooklyn—A. Stockhammer, 1368 St. Johns Place, will install a steam heating plant in the 2 story, 100x120 ft. theatre which it plans to build on St. Johns Place and Schenectady Ave. Total estimated cost, $150,000. Carlson & Wiseman, 226 Henry St., Engr.

N. Y., Clark Mills—The Adirondack Electric Power Corp., Union Sta., Utica, plans to build a 16 mi. transmission line from its substation here to one at Oneida, thereby connecting company's Oneida and Canastota plants with a high tension line.

N. Y., Norwich—R. F. Chaffee is in the market for complete ice plant equipment, to include compressor, freezing tank, can moulds and power plant; preferably oil engine drive. Plant to have capacity of 20 tons ice per day and little additional refrigeration to take care of 4800 cu.ft. ice storage space.

N. Y., Rensselaer—W. S. Clark, c/o the Board of Education, will receive bids for installing a steam heating boiler in P. S. No. 2. Estimated cost, $1,500.

N. Y., St. Johnsville—The Dolgeville Felt Shoe Co., Little Falls, has taken over the Englehardt factory here and will install power and transmission machinery for the manufacture of felt shoes and slippers. Address I. E. Stacey, 28 Waverly Place, Little Falls.

N. J., Toms River—The New Jersey Public Utilities Commission has ordered the Ocean County Gas Co. to build additions to its plant here. Plans include the installation of an additional generating unit and a larger steam boiler.

Va., Norfolk—R. E. Sparks, St. George Hotel, is in the market for an electrical welding machine, motor generator and switchboard. Would like to receive catalogues and prices on same.

Fla., Miami—The East Coast Cattle Co., 1425 Ave. D, plans to build a cold storage plant here.

Fla., Miami—The Miami Electric Light & Power Co., 12th and Court St., plan to enlarge its plant. Estimated cost, $200,000. H. H. Hyman, Mgr.

La., New Orleans—The New Orleans Petroleum Co., Woolworth Bldg., New York City, will install turbine generators in the oil refinery which it plans to build 15 mi. from here. Total estimated cost, $1,500,000. Work will be done by day labor.

Tenn., Harriman—The city is in the market for a center crank, self contained, high speed engine of from 200-250 h.p. (Ideal or Skinner, preferred) and for this engine one 2300 V, 3 phase, 60 cycle, generator or direct connected unit of the same size. R. C. Walzl, Supt. of Water Wks.

Ohio, Cleveland—The Aluminum Castings Co., 2800 Howard Ave., plans to build a power house on Howard Ave. and East 28th St. Estimated cost, $50,000. G. S. Rider Co., 612 Century Bldg., Arch.

Ohio, Cleveland—O. P. Brown, 304 East St., New Castle, Penn., W. M. Brown Estate, will install a steam heating plant in the 10 story mercantile building which he plans to build at 1110 Superior Ave. Total estimated cost, $100,000.

Ohio, Cleveland—The Clark Manufacturing Co., East 38th St. and Perkins Ave., will install a steam heating plant in the 3 story, 100x144 ft. addition to its factory. Total estimated cost, $100,000. H. E. Shimmin, 2053 Euclid Ave., Engr.

Ohio, Cleveland—J. M. & L. A. Osborne Co., Superior Viaduct, will install a steam heating plant in the 2 story warehouse which it plans to build on Superior Ave. and East 39th St. Total estimated cost, $300,000. G. S. Rider Co., 612 Century Bldg., Arch.

Ohio, Newark—W. S. Weiant & Son plans to build a 2,000 h.p. boiler plant also to change 30,000 ft. hot water radiation to vacuum steam, and is in the market for 1 a.c. turbine generator set of about 35 kw., 440 volts, 60 cycle, also feed water heater, vacuum pumps and boiler feed pumps.

Ind., South Bend—The Studebaker Corp., Brush and Piquette St., Detroit, Mich., plans to build a 4 story factory here. Plans include the construction of a power house, machine shop etc. Total estimated cost, $1,650,000. W. F. Wollering, 1st Vice-Pres.

Ill., Chicago—I. Blum, 919 Fulton St., will install a 50 h.p. motor and 15 ton ice machine in the 3 story, 50x118 ft meat products plant which he plans to build at 942 Fulton St. Total estimated cost, $80,000. G. H. Grussing, 154 West Randolph St., Arch.

Ill., Chicago—The Brighton Theatre Co., c/o A. L. Levy, Arch., 28 North Clark St., will install a steam heating plant in the 2 story, 100x160 ft. theatre and office building which it plans to build on Archer Ave. and Sacramento Blvd. Total estimated cost, $235,000.

Ill., Chicago—The Melville Clark Piano Co., 25 East Jackson St., will install a 300 hp. high pressure boiler in the factory which it plans to build on Kedzie Ave. and 48th St. Total estimated cost, $400,000. Mundie & Jensen, 39 South La Salle St., Arch.

Ill., Chicago—The South Chicago Savings Bank, 3017 East 92nd St., will install a steam heating plant in the 4 story, 55x160 ft. bank, store and offices which it plans to build on 92nd St. and Commercial Ave. Total estimated cost, $200,000. Ivar Viehe-Naess, 64 East Van Buren St., Arch.

Ill., Columbia—The city will soon receive bids for installing boilers, chimney, engine, and generator, switchboard, steam specialties piping etc., in the electric light and power plant. Fuller & Beard, Chemical Bldg., St. Louis, Mo., Engrs.

Ill., East St. Louis—Swift & Co., National Stockyards, will build a 500 ton, 22x48 ft. ice machine. Estimated cost, $114,000. T. P. Middleton, c/o owner, Engr. Owner will build by day labor.

Ill., Elmhurst—The Board of Education will install a steam heating plant in the 2 story, 152x168 ft. high school which it plans to build here. Total estimated cost, $125,000. J. C. Llewellyn, 38 South Dearborn St., Chicago, Arch.

Wis., Sheboygan—R. C. Clark, Arch., Builders Exchange Bldg., Chicago, Ill., will receive bids about May 1 for the construction of a 1 story, 40x250 ft. cooler room on South Water St., for Armour & Co. Estimated cost, $22,000.

Neb., Lincoln—T. H. Berg, City Clk., will receive bids until April 30 for furnishing and erecting oil engine and generator, direct connected, about 300 kw., 80% p.f., 60 cycle, 3 ph., 4400 v., exciter, oil and air piping, exhaust muffler, etc. Estimated cost, $50,000. A. Dobson, City Engr. Noted Apr. 1.

S. D., Madison—The city plans election soon to vote on $125,000 bonds for rebuilding the electric light and power house recently destroyed by fire.

S. D., Sioux Falls—The Northern States Power Co. plans to enlarge and improve its plant. Plans include the installation of a 3,000 kw., steam turbine and complete rebuilding of the power distribution system. Estimated cost, $500,000. N. C. Draper, Mgr.

Mont., Livingston—R. C. Fuhrman is back of a movement to form a stock company to construct and operate a 20-ton artificial ice plant. Estimated cost, $20,000.

Mo., Joplin—The Y. M. C. A. will install a steam heating plant, motors, boilers and engine in the 5 story, 103x129 ft. building which it plans to build on 5th Ave. and Wall St. Total estimated cost, $209,627. Smith, Rea & Lovitt, Frisco Bldg., Arch.

Mo., St. Louis—The Mineral Refining & Chemical Corp., Iron Mountain tracks and Des Pere River, will require power equipment in building an addition to its plant and pigment plant. Total estimated cost, $500,000. A. E. F. Versen, c/o the owner, Engr.

Colo., Stoneham—The city plans election soon to vote on $40,000 bond issue for the construction of a light plant and waterworks system.

Cal., Corcoran—The Corcoran Irrigation District will petition the Bd. of Supervs. Kings Co., Hanford, for authorization to form irrigation district. Plans include the construction of dams, reservoirs, canals, wells, and the installation of pumps, etc.

Cal., Los Angeles—J. P. Vroman, Sec'y., Bd. of Pub. Wks., 645 South Olive St., will soon award the contract for furnishing distribution transformers for the light and power system. E. F. Scattergood, Ch. Electr. Engr.

Que., Chicoutimi—The Saguenay Power Co. has been incorporated with $3,000,000 capital, by A. Lemieux, 107 St. James St., and others, for constructing and exploiting hydraulic gas and electric workshops and the distribution of electricity, gas, etc.

Que., Donnacona—The Donnacona Paper Co. has purchased 183,360 acres of timber land on the Jaques Cartier River 27 mi. from Quebec and plans development; to include dam, flume, power house and installing electric generating equipment. G. H. P. Gould, Lyons Falls, N. Y., Pres.

Que., Quebec—The Marine Department, Ottawa, Ont., will require 2 boilers for the Canadian Government Steamer "Montcalm". Estimated cost, $70,000. F. Macdonnell, Engr.

Que., Verdun—The city plans to build extensoins to the water and electric plant. Estimated cost, $150,000. A. E. Cohy Sons, City Hall, Engr.

Ont., London—J. & J. J. Allen will install complete steam heating equipment in the theater, store and office building which it plans to build on Dundas St. Total estimated cost, $200,000. C. H. Crane & E. G. Kiehler, 2325 Dime Bank Bldg., Detroit, Mich., Arch.

CONTRACTS AWARDED

N. Y., Buffalo—The Board of Education received bids for installing heating and ventilating systems in P. S. No. 8, from H. J. Wood & Co., 1358 Main St., $50,949; electrical work, from the Buffalo Electrical Construction Co., 18 Bway., $7,800.

N. Y., New York—The Board of Education received bids for installing heating and ventilating apparatus in P. S. 40, from D. J. Rice, 42nd St. and Lexington Ave., $62,173; Gillis & Geoghegan, 537 West Bway., $66,478; Teran, Mahaney, Monroe, Grand Central Terminal, $67,300.

N. Y., Whitesboro—The Board of Education has awarded the contract for installing a heating and ventilating system and electric equipment in the high school building here, to the P. W. Schneider Co. Inc., 16 Pearl St., Utica, $17,210, and to the J. & M. Electric Co., 26 Bank St., Utica, $3,900 respectively.

Md., Towson—The St. Vincent's Male Orphan Asylum, York Rd., received lowest bid for altering existing buildings and constructing a 1 story, 40x50 ft. boiler house, from J. J. O'Connor, 52 Knickerbocker Bldg., Baltimore. Estimated cost, $50,000.

Mich., Detroit—The Board of Water Commissioners, 232 Jefferson Ave., has awarded the contract for the construction of a 1 story, 54x90 ft. boiler house and steel coal hoppers, to Lennane Bros., Union Trust Bldg. and F. E. Chapper Iron Works, 128 Fort St., E.; $27,238.

Mich., Wyandotte—The city has awarded the contract for furnishing and installing 2 low lift, motor driven centrifugal pumping units 2100 and 4200 gallons per minute, also steam driven pumping unit, 5,000,000 gallon capacity, horizontal cross compound crank and fly wheel pumping engine, to the Platt Iron Works, Arrott Bldg., Pittsburg, Penn. Estimated cost, $12,000. Noted Feb. 26.

Ill., Chicago—The Eagle Ice Co., 4946 Federal St., has awarded the contract for the construction of a 2 story, 70x175 ft. ice factory, to A. C. Wehrwein, 6428 Vernon Ave. Estimated cost, $20,000. E. G. McClellan, 38 South Dearborn St., Arch.

Minn., Hibbing—The Hibbing Power & Light Department has awarded the contract for the construction of a 3 story, 100x160 ft. power house on 6th Ave. and Wilson St., to the National Electric Construction Co., St. Paul; full battery of electric dynamos, water generators, boilers and electrical equipment will be installed in same. Total estimated cost, $700,959. Noted Jan. 7.

Neb., Omaha—The Higgins Packing Co., 1215 Woodmen of the World Bldg., has awarded the contract for the construction of the first unit of the cold storage plant, 4 story, 50x100 ft. on 36th and L St., to J. Hansen, 803 Ave. F, Council Bluffs, Ia. Estimated cost, $70,000.

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